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COMMERCIAL FISHERIES Review

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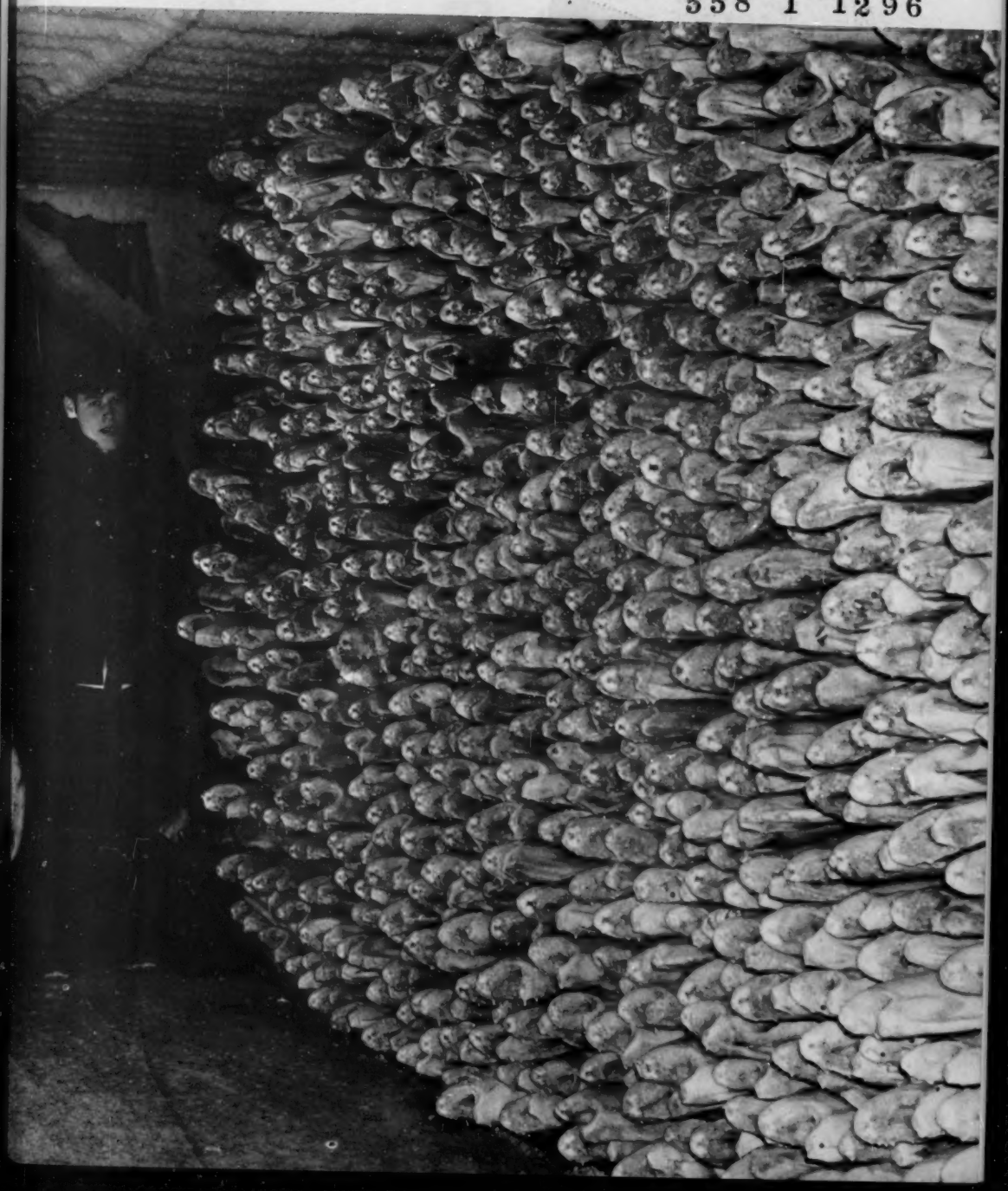

COVER: Cords of salmon are stored in this Juneau, Alaska, cold-storage plant. (BCF-Alaska photo: J. M. Olson)

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COMMERCIAL FISHERIES

Review

A comprehensive view of United States and foreign fishing industries--including catch, processing, marketing, research, and legislation--prepared by the Bureau of Commercial Fisheries.

Fishermen's Memorial
Gloucester, Mass.

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Throughout this book, the initials BCF stand for the Bureau of Commercial Fisheries.

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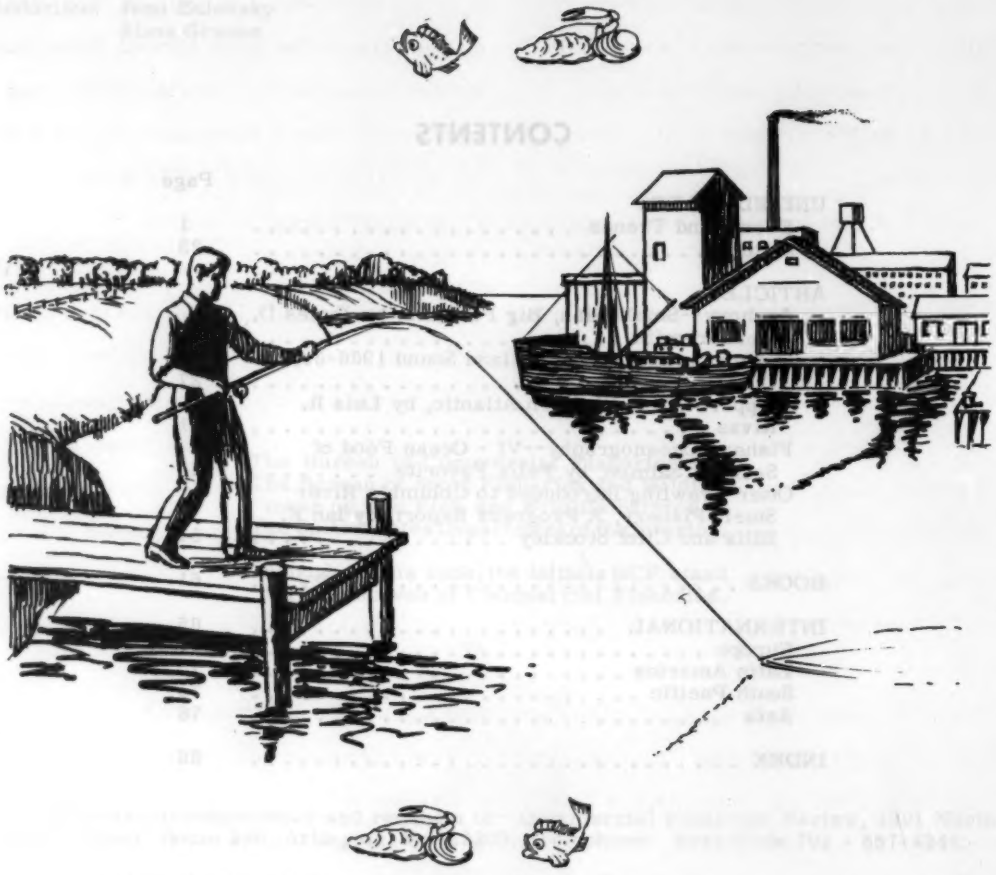


U. S. 1969 CATCH OF FISH & SHELLFISH IS 4.2-4.3 BILLION POUNDS

U.S. fishermen caught between 4.2 and 4.3 billion pounds of fish and shellfish in 1969. The catch brought them a record income exceeding $475 million and approaching $480 million. The previous record year was $472 million. These preliminary data were reported by BCF's Division of Statistics and Market News.

In 1968, 4.1 billion pounds sold for $471.5 million.

The 1969 catch was only slightly larger than the two previous low-volume years and the third smallest domestic catch since 1942. (Record catch--5.4 billion pounds in 1962.)

Some Sharp Declines

Landings declined sharply for haddock, sea herring, whiting, and sea-scallop meats at New England ports. In the Pacific Northwest, the salmon harvest ranked with the smallest of the 20th Century. Fishing for menhaden along the Atlantic Coast generally was poor, but the Gulf of Mexico catch was a record.

Some Good Increases

There were good increases in landings of anchovies, cod, halibut, jack mackerel, and tuna.

Shrimp Slips in Gulf of Mexico

Production of shrimp in the Gulf slipped below 1968 but, for the first time, fishermen received more than $100 million. The catch dropped also in the South Atlantic States, but the developing shrimp fisheries off New England and the Pacific Northwest kept the U.S. shrimp catch at about the 1968 level.

Total Supply Drops

The supply of all fishery products (round weight) was 12.6 to 13 billion pounds--about 25% below 1968's record 17.3 billion pounds. The loss was entirely in nonedible products--resulting from a 40-45% decrease in fish-meal imports. The supply for food was a little higher than 1968's 5½ billion pounds. Of all fishery products, domestic fisheries accounted for 33% (24% in 1968); imports were 67% (76% in 1968).

Per-Capita Use & Consumption

It was predicted that per-capita utilization of all products (round weight) would drop 28%: from 87 pounds in 1968 to 63 pounds in 1969. Per-capita consumption would remain near the high 1968 level of 11 pounds per person.

PHILIP M. ROEDEL NAMED BCF DIRECTOR

Philip M. Roedel, Chief of California's Marine Resources Program, has been named Director of the Bureau of Commercial Fisheries. He succeeds H. E. Crowther, recently appointed Deputy Commissioner of Fish and Wildlife.

Roedel, 56, an internationally known fishery scientist and administrator, has been actively engaged in the fishery world for more than 30 years.

Secretary of the Interior Walter J. Hickel said: "Mr. Roedel is eminently qualified to head the Bureau. We know he will bring to this position the same talent and energy which has earned him such an enviable reputation in the fishing industry as well as in the scientific community."

He Sees Opportunity

Mr. Roedel said it was a great opportunity to join BCF at this time to help strengthen all aspects of the U.S. fishing industry. "Many problems face both government and industry. We must help the industry and, at the same time, make the best use of the resources available to us. We have to take a hard look at what we are doing now--to chart a course that will provide the best service in the future to our Nation and its people. We must select our goals and priorities carefully." He said he looked forward to working at the national level with all segments of the fishing business to achieve the goals selected.

Mr. Roedel, who had close professional associations with BCF for many years, emphasized his great respect for the organization and his pleasure at joining it.

Background

The new director received an AB from Stanford University in 1935. In 1936, he began his professional career as a marine biologist with California's State Fisheries Laboratory.

During World War II, he served in the Army 4 years, first as an enlisted man in the Medical Department, and later as a commissioned officer in the Medical Administrative Corps.

He resumed his professional career in 1946 and earned his master's degree in biological sciences at Stanford in 1952.

State, U.S., World Duties

Roedel held positions of increasing responsibility in California, specializing in marine fisheries. He served on U.S. delegations to international fishery conferences and as consultant to FAO.

He represented California at national fishery meetings and, in 1967 and 1969, on the U.S. State Department Fishing Industry Advisory Council.

He is the author of many scientific papers, a Fellow of American Institute of Fisheries Research Biologists, and a member of fishery societies and other scientific groups.

Director Roedel is married to the former Geraldine Harney. They have two children: David, 20, and Deborah, 18.

BCF SCUBA TEAM STUDIES LOBSTER BEHAVIOR

Studies of lobster behavior by a SCUBA team of BCF's Boothbay Biological Laboratory (Maine) show relative abundance of lobsters in the inshore waters remains constant throughout the year. This suggests that these lobsters do not make extensive seasonal onshore-offshore migrations.

Active At Night

Small-scale movements do occur during stormy weather and strong vertical turbulence in the water. During stormy weather, the divers saw lobsters occupying relatively shallow burrows in 40 feet of water or less move to greater depths. The movements generally involved horizontal distances of 100 yards or less, and an increase in depth of 20 to 30 feet. Lobsters were nocturnally active throughout the year. They left their burrows at about sundown and returned just before sunrise. Lobsters less than 45 mm. were not active at night.

5 GREAT LAKES STATES CONDUCT PESTICIDE MONITORING PROGRAM

The natural resources agencies of Michigan, Indiana, Illinois, Minnesota, and Wisconsin have mobilized a $300,000 pesticide monitoring program in the upper Great Lakes. Their targets: "Tributary streams to pinpoint major sources of pesticide pollution along this big body of water."

The states acted after the U.S. Food and Drug Administration seized more than 30,000 pounds of Lake Michigan coho salmon containing too much DDT.

DR. A. R. LONGHURST HONORED BY LONDON UNIVERSITY

The Senate of the University of London has conferred the Degree of Doctor of Science on Dr. Alan R. Longhurst, Director, Fishery-Oceanography Center, BCF, La Jolla, Calif. The degree honors his work in marine biology. Dr. Longhurst earned his Ph. D. at London.

SAFE-BOATING BILL PROPOSED BY TRANSPORTATION DEPARTMENT

The Secretary of Transportation has sent to Congress a Federal Safe Boating proposal. It would allow the Department to establish minimum safe standards for boats and equipment. The proposal includes a 5-year financial assistance program to encourage States to increase their safe-boating efforts.

INTERIOR ASKS CHANGES IN FISH PROTEIN CONCENTRATE RULES

The Department of the Interior has asked the U.S. Food and Drug Administration to permit the use of fish species besides hake in the making of fish protein concentrate (FPC). The notice was published in the 'Federal Register' Dec. 24, 1969.

Under current regulations, FPC may be manufactured only from "hake or hakelike" fish. Continuing research has shown that a safe and wholesome product also can be made from fatty fish, such as herring and menhaden.

Closer to Commercial Reality

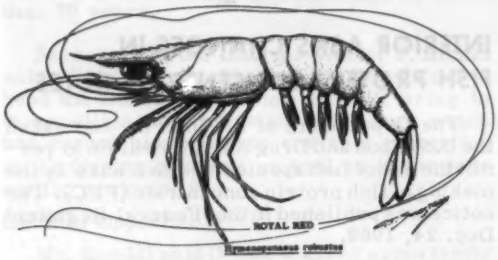
Dr. Leslie L. Glasgow, Assistant Secretary of the Interior for Fish and Wildlife, Parks and Marine Resources, said:

"Permission to use fatty fish, which are found in abundance off our shores, and small, bony, or other unused fish, will put industry into a more favorable position to get into the FPC business.

"We believe the United States must assume leadership in research to increase the world food base. The FPC research of our Department, which has had the benefit of advice from the National Academy of Sciences, is a firm step in the direction of that leadership."

ROYAL-RED SHRIMP CONCENTRATED IN 3 POTENTIAL COMMERCIAL AREAS

The royal-red shrimp (Hymenopenoeus robustus) is an underused species. Although it is a typical penaeid, it differs from commercial penaeids of the genus Penaeus because it prefers deep, cold water. It inhabits the upper Continental Slope from as far north



as Cape Hatteras, North Carolina, to as far south as the coast of the Guianas in South America. But it is abundant in only a few areas. Little is known of its biology, particularly its reproduction and early life history.

3 Potential Commercial Areas

Royal-red shrimp concentrations in the Gulf of Mexico were discovered in 1950. Since then, BCF's Exploratory Fishing and Gear Research Base, Pascagoula, Miss., has made periodic trawling surveys along the Continental Slope from North Carolina to Brazil to evaluate the commercial potential. The results indicate that three grounds off the U.S. coast support commercial quantities of royal-red shrimp: east of St. Augustine, Florida, in the western Atlantic; south-southwest of the Dry Tortugas in the Florida Straits; and southeast of the Mississippi River Delta in the Gulf of Mexico.

How Catch Divided

Preliminary records indicate the 1968 U.S. commercial catch of royal-red shrimp was less than 120,000 pounds (heads-off). Of this total, 53% came from the Mississippi River Delta area, 39% from off St. Augustine, and 8% from Dry Tortugas area.

Soft Bottom, 8°-12° C.

The distribution of royal-red shrimp is restricted to soft-bottom types and to water temperatures of 8° to 12° C. The highest shrimp concentration is in 9° to 10° C. water.

Shrimp densities vary seasonally on all three grounds. Late summer and fall are periods of high density on the St. Augustine and Mississippi Delta grounds; late spring and summer for the Dry Tortugas grounds.

Depth Distribution Varies Seasonally

The depth distribution of shrimp also varies seasonally: the shrimp move offshore in summer and inshore in winter. Shrimp occur at 255 to 550 meters on St. Augustine grounds; 275 to over 550 meters on Dry Tortugas; and at 275 to over 550 meters on Mississippi Delta area. Within each range, seasonal variation in concentration is considerable.

BLUE CRABS ABOUND IN CHESAPEAKE BAY

Blue crabs are more abundant in Chesapeake Bay now than at any time in the past 90 years. Not since commercial fishing started in the 1870s have so many been reported.

This bountiful supply was predicted in October 1968 by W. A. Van Engel of the Virginia Institute of Marine Science, and Robert L. Lippson of Maryland's Chesapeake Biological Laboratory. The 2 scientists predicted a Virginia-Maryland catch--barring trouble from weather, labor, and markets--of over 100 million pounds from September 1969 through August 1970. The previous 12-month high was 97½ million pounds in 1966. They also predicted the catch could remain high through December 1970.

Crab dredge boat.

Hatched In 1968

Many of the crabs hatched in 1968 had reached mature size by September 1969; these will support the commercial fishery until early summer 1970. Crabs hatched late in 1968 will reach maturity in early summer 1970, supporting the fishery until the end of the year.

Catch Doubled in Fall 1969

This abundance follows almost 2 years of scarcity--1968 and first two-thirds of 1969--when production fell to less than half former levels, and prices rose to record highs. Through November 1969, crab potters already had doubled their fall 1968 catches. The winter dredge fishing began on December 1, 1969. Virginia vessels should have been able to take the 25 barrels a day per-boat-catch limits in record time.

Hurricane Damage

Van Engel warned that the full effect of Hurricane Camille on Virginia stocks may not yet be known. Torrential rains and high runoff caused substantial reductions in river and bay salinities. This resulted in some freshwater kill of crabs on the James and York rivers. Since experimental trawl and dredge surveys have not located as many crabs as expected, the kill might have been even greater than originally thought.

Poor 1969 Hatch

Van Engel and Lippson are pessimistic about the 1969 hatch, which will provide the fishery from September 1970 through August 1971. Surveys made in fall 1969 failed to locate more than a few small crabs ½ to 1½ inches wide, about the same number found in fall 1966 and 1967. The small numbers in those years resulted in the scarcities of 1968 and 1969.

Both states expect to keep a close watch on the new crop during 1970. The prospects, good or poor, for the season starting September 1970 should be discernible in early summer 1970.

Blue Crab

'DELAWARE II' MAKES LARGE BUT NOT PROFITABLE SEA-HERRING CATCHES

The Delaware II of BCF's Exploratory Fishing and Gear Research Base (Gloucester, Mass.) conducted industrial-fish investigations in the western Gulf of Maine between Sept. 30 and Oct. 31, 1969.

Fifty-nine tows caught 0 to 60,000 pounds of herring per tow. Despite large catches, the scientific personnel emphasize: "At current market prices for industrial fish species, the fish caught during this cruise would not have equaled the size of catch needed for profitable commercial operations. However, the demonstrated capabilities of the midwater fishing method should be adequate and suitable for commercial use at times and in areas whenever herring can be found in some abundance. The next scheduled industrial fish cruise is planned to continue evaluation of the suitability of this fishing method in areas of seasonal herring abundance."

Cruise's Primary Purpose

The primary purpose of this cruise was to evaluate the commercial potentials of the midwater trawl fishing method for taking fish species of value for reduction to meal and oil. A closely associated objective was refinement of the midwater trawling technique.

Tows & Catches

The tows varied from 20 minutes to 4 hours; larger catches were made on fairly short tows on good traces of fish.

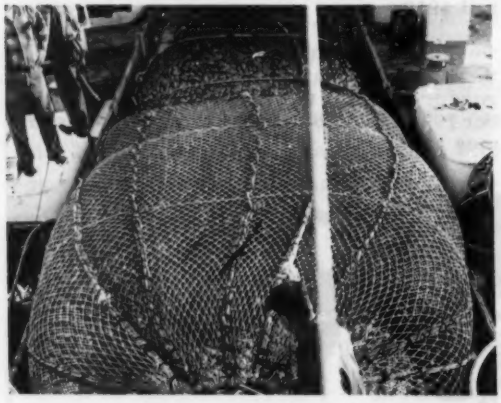


Fig. 1 - A 55,000-pound catch of sea herring.

The two largest catches--60,000 and 55,000 pounds--were taken on 40-minute sets; these short sets were terminated to prevent overloading the net.

A total of 322,188 pounds of fish were caught: 307,627 pounds herring; 12,380 pounds mackerel, 1,380 pounds whiting, 134 pounds cod, and 667 pounds other species.

Cruise 69-9 was broken from October 10 to 17 for shipyard installation of a transducer for the scientific sounder and to change scientific personnel.

Fishing Gear Used

A medium-sized, West German-type midwater trawl was fished exclusively. This 4-seam (Herman Engel) net measures 1,400 meshes around the net at the front of the bellies. Mesh size is 8 inches (stretched mesh) in the wings and forward part of the bellies. The mesh tapers from 8 inches to $1\frac{1}{2}$ inches in the lower part of the bellies, extension, and cod end. The length of the net (from tips of wing ends to extremity of cod end) is about 380 feet.

A set of "beefed-up" 8-foot (height) by 4-foot (width) Suberkrub doors was used to spread this net. Although these doors were very stable while fishing, it is recommended that larger size (10' x 6') doors should be used. The larger doors should give greater horizontal opening to the net.

Improved lifting devices on headrope with heavier chain on footrope should increase net's vertical opening from 7 fathoms generally experienced during cruise to perhaps 10 fathoms. With higher and wider opening, larger catches could be made in less time. This would be feasible only if straining the extra amount of water did not increase the net's drag beyond vessel's towing capabilities.

Fishing Procedure

An acoustical search was conducted to find good fish traces before the net was set. During this cruise, the productive areas located were fished much more intensively than during earlier cruises. Fishing was broken off and scouting begun only when good fish targets

KEY
OCTOBER 17 - 31
KEY
OCTOBER 1 - 10
Maine
Jeffreys
Ledge
Stellwagen
Bank
Jim
Dwyers
Ridge
Nantucket
Shoals
Cape
Cod
44°
43°
42°
41°
71°
70°
69°
68°

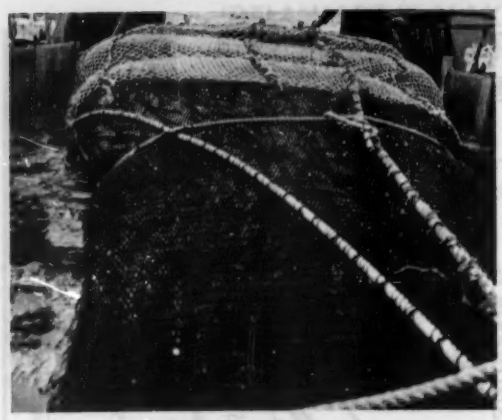


Fig. 3 - A 20,000-pound herring catch.

could no longer be found. While fishing on good signs of fish, the tows were terminated when a fairly good catch had been made. The crew avoided making the largest catch possible because of handling difficulty and time lost in bringing very large catches aboard. For the Delaware II's present catch-handling arrangement, 20,000 to 30,000 pounds are fair-sized catches for ready handling.

Area Fished

Three areas were generally scouted and fished when fish concentrations were found: Jeffreys Ledge, Stellwagen Bank, and eastern offing of Cape Cod and Nantucket Shoals.

The most productive area was in offing of Cape Cod between Highlands and Nauset. However, foreign fleets had just recently heavily fished these areas (outside 12-mile Contiguous Zone). Each fleet had departed in a generally successive north-to-southward movement. The foreign fleet was reported concentrated in offing of Martha's Vineyard to Block Island.

Near the end of the cruise, a quick look was taken over Jim Dwyer's Ridge (on eastern side of Great South Channel). Only scattered traces of fish were found; samples were mostly whiting.

Results and Observations

Cruise results were excellent in regard to primary purpose. In areas recently fished heavily by foreign fleets, a daily production rate of 70,000 pounds of herring was maintained on October 7, 8, and 9. The largest catches curtailed production because of excessive time lost bringing the catches aboard. If herring were available, the midwater trawl probably could catch as many fish during a set as any boat could bring aboard. Each vessel's capability would depend on how the vessel was rigged.

Herring's Behavior

Sustained and uninterrupted fishing production depends largely on the herring's continuous availability. It was found that availability is not simply a matter of supply--but also of the herring's schooling behavior. During bright days, herring were found to be hard on the bottom during midday hours. They bunched up in the afternoon, and rose to surface in large concentrations during late afternoon and early evening. Upon reaching surface, the herring spread out and dispersed in a shallow surface water layer. As light increased in the morning, the fish gathered in small groups to return to the bottom. The groups that left the surface seemed to consolidate into larger schools before dispersing over the bottom. On dark and overcast days, the fish tended to remain in lower levels of water column without settling to bottom. On bright moonlit nights, they were slow in rising to surface. In any case, the fish were most susceptible to capture between bottom and surface. A successful technique for surface trawling at night (when developed) could extend production hours correspondingly.

Night Trawling Caught Mackerel

Mackerel predominated during nighttime trawling; one tow took 6,000 pounds. It is possible that mackerel may occur at different distances than herring below the surface. So an improved surface-towing technique could increase nighttime herring catch over mackerel catch. However, the market value should determine which fish would be primary target.

ANCHOVY--SMALL FISH, BIG PROBLEM

James D. Messersmith

A small but valuable fish of great interest to sports and commercial fishermen has been the subject of considerable concern in California recently. This is the anchovy--more properly known as the northern anchovy or Engraulis mordax.

It might be said that the basic use of the anchovy is as food for larger fish. Sportsmen are interested in the anchovy because it is the most desirable live bait available, and they yearly use more than 5,000 tons as live bait.

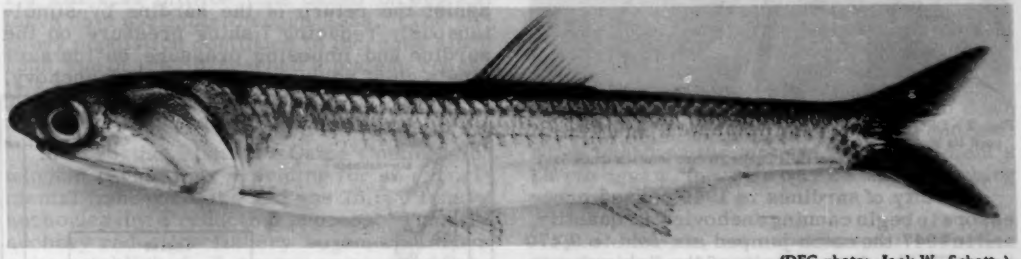
The anchovy also supports an important commercial fishery. Some of the commercial catch is canned, primarily for export, and a share is used in canned pet foods. In addition, huge quantities of the fish are reduced for use as a protein supplement in animal and poultry foods and for fertilizer.

The controversy is intensified because the anchovy is important as forage for fishes of interest to sportfishermen and because of the history of the overharvested Pacific sardine resource.

What happened to the sardine?

The sardine fishery reached its peak in California in the thirties and early forties. In 1936 Dr. Frances N. Clark, then director of the State Fisheries Laboratory, predicted a decline of the sardine fishery on the basis of studies she made on the catch-per-effort of fishing boats. It had become increasingly more difficult for the boats to make high catches by that time. A succession of exceptionally good years delayed the decline, but the sardine fishery eventually collapsed.

Then, as now, the Fish and Game Commission and the Department of Fish and Game were in favor of scientific management of fisheries, but they were unable to achieve a curtailment in the rate of harvest, and this contributed to the collapse.



(DFG photo: Jack W. Schott.)

During the past few years a spirited controversy over the anchovy has arisen among special interest groups concerned with fisheries. This controversy revolves around:

1. Recommendations by state, university, and federal marine scientists that a larger percentage of the available anchovy resource be harvested;

2. Requests by the fishing industry for larger reduction quotas; and,

3. Unyielding opposition to such proposals by sport fishermen who use anchovies for live bait and chum.

Although the sardine population was allowed to decline, this does not mean now that nothing should be harvested. While scientific management implies that resources must not be overharvested, it also implies that resources should be utilized fully.

The Department's position is still consistent. It is still in favor of management--in favor of not overharvesting any of the marine resources--and in favor of not "giving away" the anchovies, either.

Mr. Messersmith is Assistant Chief, Marine Resources Branch, California Department of Fish and Game.
Article reprinted from OUTDOOR CALIFORNIA, Sept.-Oct. 1969.

Reliable records of commercial anchovy landings used for human consumption, dead bait, feeding in fish hatcheries and mink farms, and reduction to oil and meal date from 1916. Average annual landings through 1921 were only 504.5 tons, mostly for reduction to oil and meal.

In 1919 a law was passed prohibiting the reduction of whole fish except under permit. Teeth were put into the law in 1921, resulting in reduced landings averaging 159 tons for the next 17 years. Between 1939 and 1946, landings averaged 1,454 tons.

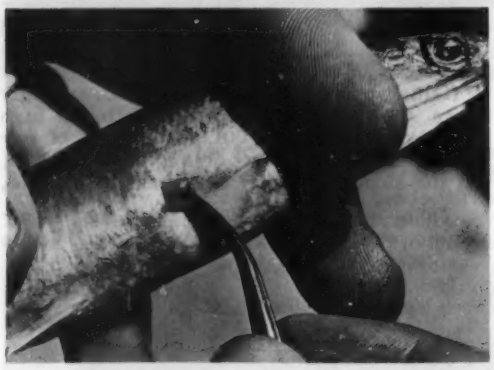


Fig. 2 - DFG biologist inserts a metal tag in an anchovy to record its movements.
(Photo: Bill Beebe, Santa Monica Outlook.)

Scarcity of sardines in 1946 caused processors to begin canning anchovies in quantity, and in 1947 the catch jumped six-fold to 9,470 tons. The landing capacity of the fishing boats exceeded the canning needs of plants, and excess deliveries were diverted to reduction plants.

To lower the amount of anchovies reduced, the Fish and Game Commission required each processor to place a high proportion of each ton of anchovies in cans.

With the temporary resurgence of the sardine through 1951, anchovy canning declined. But with the collapse of the sardine fishery in 1952, anchovy landings increased to 27,891 tons and to 42,918 tons in 1953.

Because of economic conditions and presumably low consumer acceptance of the canned product, landings declined to 19,400 tons in 1957 and 5,200 tons in 1958. Landings did not again exceed 5,000 tons until 1966 when, for the first time in more than forty years, anchovies were fished solely for reduction purposes.

Anchovies are very important in California as live and dead bait. Records of the live bait catch were initiated in 1939 and, except during World War II, have been submitted voluntarily ever since. These records account for most of the catch, but are not complete because some operators do not submit records.

When records were first started, live bait landings were 1,074 tons and accounted for 58 percent of the statewide anchovy catch. Since 1950, anchovy live bait landings have fluctuated between 3,800 and 6,800 tons, averaging 5,570 tons for the past several years.

Why the interest in harvesting anchovies in large quantities?

In 1964 the California Cooperative Oceanic Fisheries Investigations (CalCOFI) Committee proposed an ecological experiment to assist the return of the sardine by simultaneously reducing fishing pressure on the sardine and imposing pressure on the sardine's chief natural competitor, the anchovy.

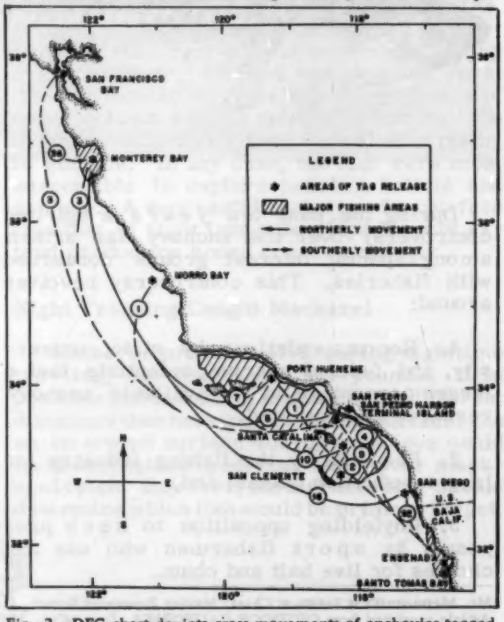


Fig. 3 - DFG chart depicts gross movements of anchovies tagged and recaptured from March 14, 1966 through May 31, 1969.

The proposed experiment consisted of three phases:

1. A controlled anchovy harvest of 200,000 tons with an annual quota for approximately three years.

2. Quota adjustments on the basis of findings during phase 1.

3. Restoring ultimately the predecline balance between sardines and anchovies and maximizing the harvest of both species consistent with all uses.

CalCOFI noted that if both the sardine fishery and competition from anchovies are affecting the sardine population--and if the objective was to bring back the sardine in the shortest possible time--there should be fishing on anchovies and a complete moratorium on sardine fishing.

At the time of this proposal the total spawning biomass of anchovies in the California Current was estimated to be between 1.8 and 2.25 million tons based on egg and larva data available through 1958. (The anchovy population continued to increase since 1958, and in 1962 it reached a plateau roughly 2.5 to 4 times greater than the 1958 estimate. It remains there today.)

In 1965 the Fish and Game Commission adopted regulations providing for an experimental fishery to take and use 75,000 tons of anchovies by a reduction process. Thus the anchovy reduction fishery began, and zones were established. A season was set and fishing was prohibited within three miles of the mainland shore.

When the Commission authorized the anchovy reduction fishery, the Department of Fish and Game initiated a project responsible for monitoring the fishery and conducting any biological studies on the anchovy necessary for resource management.

Project objectives included determination of migratory habits, estimates of population size and mortality rates, catch locations, catch per unit of effort, number and pounds of anchovies landed, the age-composition of the catch, and other fishery statistics. Initial efforts were directed toward tagging and tag recovery, and fishery monitoring of the commercial reduction and live bait fisheries.

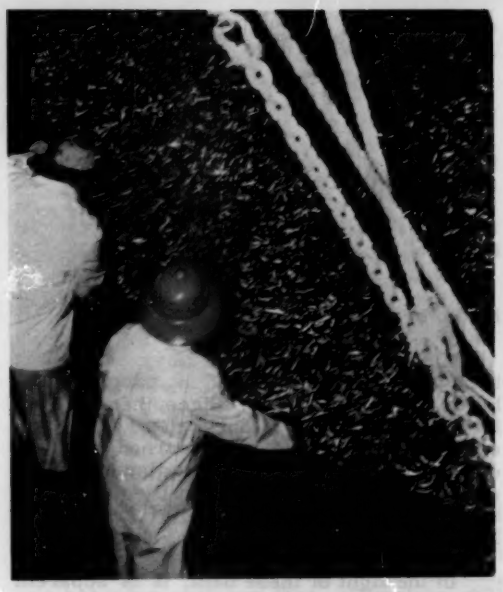


Fig. 4 - This commercial fish net holds between 60 and 80 tons of sparkling anchovies. The average size is 5½ to 6 inches. (DFG photo: The author.)

When the Fish and Game Commission established the reduction fishery, it laid down rules under which the fishery was to operate, rules based on the state of the Department's knowledge of the resource and of fishing methods.

For example, an experimental reduction fishery was authorized because of the consensus that there was a large under-utilized resource. Quotas were set and processor permits were required in order to control the growth of the fishery. Declarations of intent were required of fishermen when it became apparent that it would simplify enforcement problems.

Fishing zones were established because, in the absence of migration data, it was thought necessary in order to prevent overfishing in local areas, especially where these areas bordered prime live bait fishing grounds.

The concern was that areas bordering the live bait fishing grounds might be depleted and that they may not be replenished, by migrations, during the closed season and prior

to the critical live bait period of July and August.

At a meeting of the Commission in San Diego on July 25, 1969, DFG Director Ray Arnett said, "It is my contention that we now know enough about the anchovy movements and the reduction and live bait fisheries to state that a reduction fishery of the magnitude proposed has no effect on the live bait fishery."

He said the 1968 live bait fishery was the best on record.

"To help understand anchovy movement behavior," he said, "a tagging program was begun in March of 1966. Since then we have tagged nearly 400,000 anchovies and recovered 959 tags. . .We have learned that anchovies can and do move long distances (360 miles, for example, from San Diego to Monterey) in a short period of time (129 days, or 2.8 miles per day).

"In the light of these data, it is apparent that the zones do not provide the function for which they were created, at least as long as the season remains unchanged and the fishery continues to operate farther from shore than three miles."

Arnett said the three-year experimental program has cost about $285,000, largely license buyers' money. Patroling these zones costs approximately $60,000 each year, and the tagging program runs about $35,000 annually.

"Therefore," he said, "since the consensus is that zones no longer contribute a useful function to this experimental fishery, we recommend abolishing them."

While the Commission at that meeting did not abolish the zones, it referred to the experimental nature of the fishery and reduced the number of zones from five to three.

Arnett called the Commission's action a "workable compromise" between the Department's proposal and the desire of most sportsmen to retain the five zones.

What of the future? Will the controversy over the little anchovy continue?

Top DFG biologists look to the future with confidence. While the ocean is not a bottomless cornucopia, scientific findings point toward the existence of anchovy stocks that could support a commercial fishery greater than has ever been known in this state. And they have no reason to believe that their harvest would impinge on the legitimate requirements of sportfishermen, given only realistic controls by reasonable men.

The anchovy will not go the way of the sardine. On the contrary, judicious harvesting of the anchovy could some day lead the sardine back to a position of prominence in the coastal waters of California.

PACIFIC COAST PURSE SEINING OPERATION

BRAILING

DRYING AND MENDING

SQUID RAISED TO ADULT SIZE IN LABORATORY

One of the most important animals used in medical research--the squid--has been reared to maturity in the laboratory for the first time. Edward T. LaRoe, a graduate student at the University of Miami, has succeeded in aquarium-rearing the fast-moving, excitable Sepioteuthis sepioides, a member of the family Loliginidae from egg to adult size.

Useful in Neurological Research

Because squid have the largest nerve fibers of any animal (over 1,000 times thicker than human nerves), they are in great demand for neurological research. But the nerve fibers must be fresh, and the availability of fresh squid is a critical problem.

Seasonal & Easily Damaged

The occurrence of squid in the sea is seasonal. Loliginids are found off the northeast U.S. only in summer. During the winter, entire research teams must go to Chile and Peru for fresh squid. Squid generally undergo a true physiological shock when captured, and often are damaged by the trawls used to catch them. Once in an aquarium, they tend to swim head-on into the glass walls.

Aquaria May Provide Steady Supply

Researchers studying behavior, learning, and memory processes also need aquarium-adapted squid. With its well-developed brain and eyes, the squid has great potential for such studies. In demonstrating that laboratory-reared squid adapt to aquariums, LaRoe may have discovered a way to provide researchers a year-round, healthy supply.

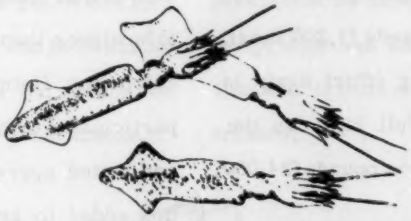
Squid reared from the egg by Edward T. LaRoe. At this age, 125 days, the squid is fed small fishes.

Benefits Commercial Fishery

Squid, valued as food in many parts of the world, is the 5th most valuable fishery product in Japan. LaRoe is gathering data on growth, food preferences, light requirements, and behavior patterns that, ultimately, will benefit the commercial fishery. He already has proved that the tropical loliginid squid grow much faster than previously believed. His squid reached maturity within 5 months after hatching, disproving a long-held theory that it took 3 years.

Laboratory Techniques

LaRoe feels his success has been due largely to his discovery of proper types of food for young squid. He feeds them small shrimp-like animals (mysids). By the time a squid is 5 days old, it will eat 50 mysids a day. Constantly studying the behavior patterns of the hatchlings, he has found certain things they prefer or like. He has adapted his rearing program to the needs of the squid.



Squid

1969 PACIFIC COAST ALBACORE TUNA CATCH IS ABOUT 24,000 TONS

Fall weather in 1969 settled on the U.S. Pacific Coast in October. It terminated virtually all fishing activity in Washington and Oregon waters. But relatively good weather off central California permitted a fleet of about 50 jigboats to continue fishing for albacore into the first week of December.

The 1969 season promises to tally between 48 and 49 million pounds (24,000-24,500 tons), reports Glenn A. Flittner, Leader of the Fishery-Oceanography Group, BCF La Jolla, Calif. Oregon and Washington again led the production race in 1969 with about 34½ million pounds (17,250 tons). California landings pulled up from an extremely poor start of 200,000 pounds (100 tons) in July 1969 to an estimated 11½ to 12 million pounds (5,750-6,000 tons) when December totals were included; nevertheless, the late-season finish failed to equal the 1968 season. The 1969 season was the worst on record in the state since 1942. British Columbia albacore landings totaled 2.4 million pounds (1,200 tons). Thus, despite heavy fishing effort again in 1969, the season's totals fell right on the 1963-68 average of 48 million pounds (24,000 tons).

Production Centers Dislocated

For the third consecutive year, major dislocations in the centers of production were observed. BCF La Jolla estimated that nearly half the entire season's production originated from waters north of Cape Flattery and off Vancouver Island; less than ½ million pounds (250 tons) originated from the district south of San Juan Seamount. The farthest northward penetration of the albacore commercial fishery was recorded in 1969: in the district northwest of Dellwood Hills, near 51°30' N. latitude, off northwest corner of Vancouver Island. A few albacore were even taken inside Hecate Strait in late August 1969.

Larger Fleet

BCF La Jolla estimates the albacore fleet in 1969 was larger than usual. The regular fleet was augmented by an appreciable number of Oregon, Washington, and British Columbia salmon trollers, and a few halibut schooners. Total fishing effort was estimated to be higher than normal. The 1969 middling catch was distributed more unevenly among participants than in 1968. Also, the 1969 season lasted appreciably longer than in 1968; this added to production costs that were not offset by other factors.

SEA LAMPREY PREYS ON LAKE HURON SALMON

Sea lamprey depredation on chinook salmon in Lake Huron is increasing. BCF scientists found 68% of the chinook from a recent catch bore lamprey scars or marks. Michigan Department of Natural Resources biologists report that over 90% are scarred in some areas of the lake. The salmon were planted in 1967.

The Lamprey

The adult sea lamprey, an eel-like parasite with sharp rasping teeth, feeds on the blood of its victims, weakening and often killing them. Entering through the St. Lawrence,

it has preyed on fishes in Lake Ontario for centuries. The deepening of the Welland Canal between Lakes Ontario and Erie during 1913-18 apparently provided the means for lampreys to enter the upper Great Lakes.

Control

Lamprey control, a joint U.S.-Canadian venture, dates from 1965, when a once-prosperous lake trout fishery had been virtually destroyed. While some trout still remained in Lake Superior, commercial catches in Lakes Huron and Michigan had dropped to less than 1% of 1930-1939 levels. About 68 million pounds were taken from the 2 lakes in those years.

Lampricide Treatment

Lamprey hatch in tributaries, where they remain for several years before transforming into the parasitic stage and migrating into the lakes. A chemical lampricide that is highly effective against the young lamprey was discovered in 1958. Properly applied, it is harmless to other fish. Chemical control was extended from Lake Superior to Lake Michigan in the 1960's; it reduced the lamprey population as much as 80-90%. While the lampricide has been used in some of Lake Huron's tributaries, many are still untreated.

OCEANOGRAPHY

NEW FILM IMPROVES UNDERWATER PHOTOS

A new film "that could help make aerial charting the most efficient method of charting shallow water areas" has been created by a technologist of the U.S. Naval Oceanographic Office (NOO). The film is insensitive to all blue light.

Willard E. Vary, the technologist, has been working in NOO experiments photographing coastlines from aircraft to chart coastal areas.

His search for a solution to the blue-light problem began after NOO's first airborne charting test in March 1967. To record ocean-bottom detail at greatest water depths with aerial photography, that test revealed, it would be necessary to filter out all or most blue light.

He Explains Problem

Mr. Vary explained:

"Aerial haze is caused by blue light scatter in the air. In the water, the blue light is the most scattered and least absorbed and this is referred to as underwater haze. These effects of blue light result in non-image-forming densities on the photographs and cause veiling or lowering of contrast in the photographs. Yellow filters on the camera partially eliminate the blue light but also decrease the exposure, often resulting in underexposed photography."

Since increased yellow filtration was not the answer, Vary thought of eliminating the blue-sensitive layer in the color film. "Color films have three layers," he explained. "One layer records the red light, one the green light and the other records the blue light. I thought it would be possible to eliminate the blue layer altogether and, with a yellow filter layer coated over the green and red sensitive layers, blue light would be prevented from affecting those layers."

Film Tested Successfully

The General Aniline Film (GAF) Corporation devised a film to meet his specifications. The new film was first used successfully in February 1968 in the Bahamas to take continuous stereo photographs of the coastal area.

Vary reported: "We recorded ocean bottom to a depth of 150 feet. The increased contrast provided by the new non-blue-sensitive film showed various underwater features in more detail."

Major Charting Method

With the new film, NOO believes, "aerial photography may now be on its way to becoming a major method of charting the ocean bottom and measuring water depths."

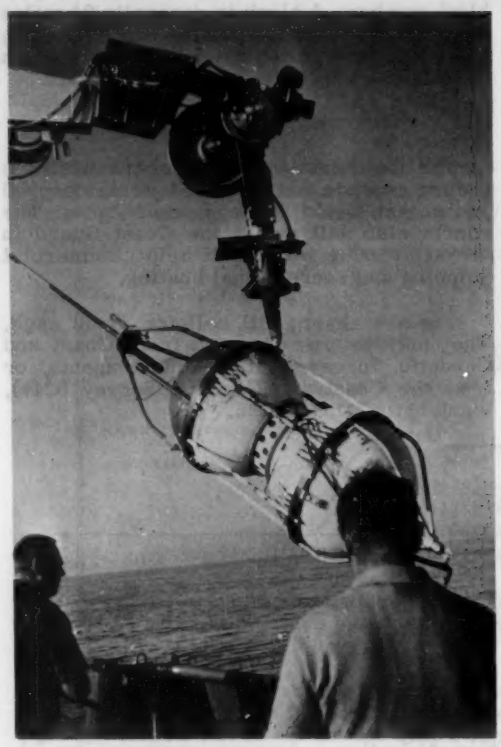
ANTARCTIC TIDES ARE BEING MEASURED

Man's first attempt to measure tides in the deep oceans surrounding Antarctica is being carried out along a 2,000-mile track running south from Australia.

Three free-falling, deep-sea, tide gauges, or capsules, were launched from the RV 'Eltanin' after her departure from Adelaide on Dec. 15, 1969. Placed 600 miles apart, at depths of 18,000, 12,000, and 15,000 feet, they will remain on the ocean floor for one lunar month.

Sophisticated Instrumentation

The gauges were designed by Frank E. Snodgrass, a research engineer with Scripps Institution of Oceanography and chief scientist aboard (Fig.). They are 'free' vehicles, not tethered to the ship. Their capsules, or hulls, are pressure-resistant aluminum spheres. Instruments attached to the capsules are measuring water temperature, current, and pressure. The capsules, which communicate with the 'mother' ship through acoustic signals, describe their operations and condition. Commands from the ship will cause them to surface at the end of the experiment. Data recorded on magnetic tape in the capsules can be computer-analyzed after recovery.



The 3 deep-sea tide gauges are similar to the one shown here. Out of photo at lower right and attached to capsule is set of storage batteries that anchors capsule on ocean floor and provides power for operating instruments and data-recording apparatus in capsule. Battery pack-anchor remains on sea bottom after capsule is recalled to surface. Frank E. Snodgrass, capsule designer, is at left.

Current Meters

Free-falling current meters also will be installed along the Eltanin's track to supplement current measurements made by the tide gauges. Similar metering was done in the Drake Passage (between the tip of South America and the Palmer Peninsula) in January 1969. From data recorded by meters placed $2\frac{1}{2}$ miles down, it was estimated that 270 million gallons of water a second flow through the Drake Passage from the Pacific to the Atlantic.

Studying Flinders Current

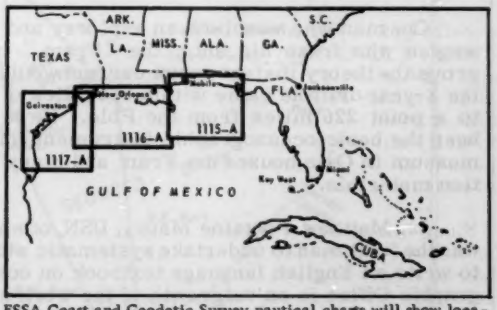
Australian scientists aboard the Eltanin are studying the Flinders Current south of Australia. They are installing gauges across the 150-mile-wide continental shelf near Adelaide and making extensive salinity, temperature, and depth measurements.

Mapping Sea Floor

A scientist from the Lamont-Doherty Geological Observatory is taking magnetic, seismic, and gravity readings while the ship is underway. This is part of a continuing program to map the sea floor and the earth's magnetic and gravity fields.

CHARTS LIST OIL-LEASE AREAS IN GULF OF MEXICO

The Coast and Geodetic Survey has announced that it will issue nautical charts before the end of 1970 showing virtually all offshore oil-lease areas in the Gulf of Mexico. The charts will cover an estimated 161,444-square-mile area containing thousands of oil wells and platforms. They will not show oil-lease areas in river estuaries, bays, inlets, etc.



ESSA Coast and Geodetic Survey nautical charts will show location of virtually all Gulf of Mexico offshore oil lease areas.

New overprinted charts, 1115-A and 1117-A, add oil-lease areas to already-existing charts 1115 and 1117.

Chart 1115-A shows the area off Mississippi and Alabama. Publication was scheduled for December 1969.

Chart 1117-A shows the area off Texas. It probably will be published in August 1970.

Chart 1116-A shows the area off Louisiana and northeast Texas. It has been available since 1957. Since an oil-lease area is re-

ferred to as a lease block, 1116-A has come to be known as the "Block Chart."

Heavy Demand

Demand for the Block Chart has increased greatly in recent years. Requests have come from operators of shrimping and fishing craft, tug boats, and other vessels frequenting the area. Originally, the lease blocks were added to help maintenance craft locate a lease area or oil rig for servicing.

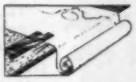
How It Works

There are more than 2,400 platforms in the Gulf of Mexico. Each carries a large sign with the owner's name, the area, and the block number. A block is generally 2½ miles square. The chart carries the block number; any boat operator can determine his position in the square by identifying a platform.

Aid to Fishermen

The new charts will help fishermen locate fishing grounds and avoid underwater capped wells that could damage their nets. The charts also will assist the Coast Guard in air-sea rescue work, and help commercial shipping and recreational boating.

The new charts will sell for $1.50 each. They may be purchased from Coast and Geodetic Survey nautical chart agents, or from the Coast and Geodetic Survey (C44), Washington, D.C. 20235.



WHO IS THE MOST FAMOUS OCEANOGRAPHER?

This is a difficult question. The scientists best known for their exploits on and in the ocean have been explorers and aquanaut Many men who have contributed most to oceanography are virtually unknown to the public.

One man who was both an explorer and oceanographer was Fridtjof Nansen, a Norwegian who froze his ship, the "Fram," into the Arctic ice off the coast of Siberia to prove the theory that an ocean current would drift a ship across the Arctic Basin. During the 3-year drift he came within 360 miles of the North Pole and then proceeded by sledge to a point 226 miles from the Pole. He is the inventor of the Nansen bottle, which has been the basic oceanographic instrument for decades and is still widely used. A special museum in Oslo houses the Fram and many other Nansen mementos, awards, and expedition materials.

Lt. Matthew Fontaine Maury, USN, often called the father of American oceanography, was the first man to undertake systematic study of the ocean as a full-time occupation and to write an English language textbook on oceanography. The present U.S. Naval Oceanographic Office is an outgrowth of the work he started before the Civil War.

Two other Americans who contributed much to oceanography were William Beebe and Henry Bigelow. Beebe, although best known for his work with the bathysphere in which he reached a depth of 3,028 feet in 1934, also directed a number of shipboard oceanographic surveys.

During his long association with the Woods Hole Oceanographic Institution, Bigelow contributed greatly to the coordination of physical, chemical, and geological studies of the oceans, leading to a more complete understanding of the interrelationships of life in the sea.

Many men who were famous for other reasons have been interested in study of the oceans. Included in the long list are Alexander the Great, Prince Albert of Monaco, Captain James Cook, Benjamin Franklin, and Commander Scott Carpenter. ("Questions About The Oceans," U.S. Naval Oceanographic Office.)

FOREIGN FISHING OFF U.S., NOVEMBER 1969

NORTHWEST ATLANTIC (Fig. 1)

105 individual fishing and support vessels sighted (256 in October 1969; 92 in November 1969).

USSR: 51 medium side trawlers, 18 factory stern trawlers, 1 factory base ship, 3 refrigerated transports, 2 tankers (about 107 vessels in October 1969; 50 early in November 1968 to about 10 at month's end). Side trawlers took moderate-to-heavy catches of herring and mackerel south of Long Island to Nantucket. Limited amounts of red hake observed on stern trawlers south of Nantucket.

Poland: 9 large side trawlers, 7 stern trawlers, 1 factory base ship (44 in October 1969; 46 in November 1968). Vessels scattered east of Cape Cod and Cultivator Shoals, and southeast of Nantucket, during first 2

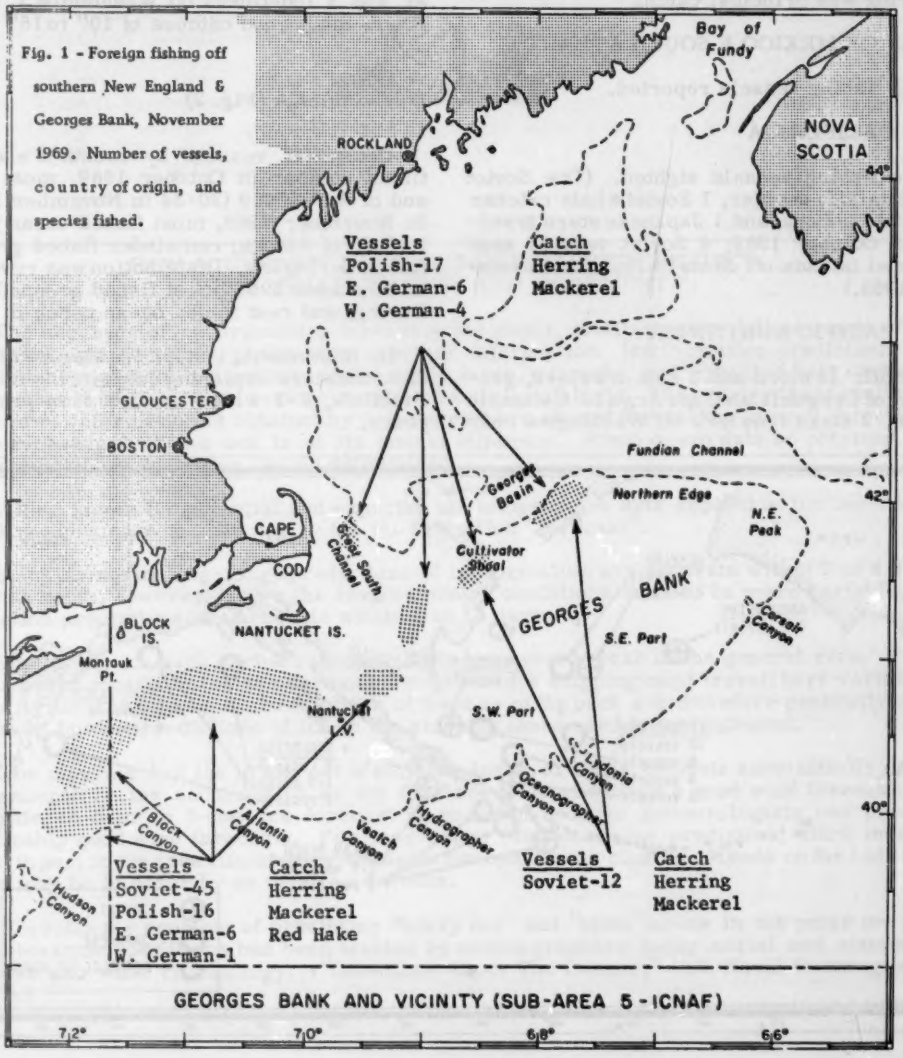


Fig. 1 - Foreign fishing off southern New England & Georges Bank, November 1969. Number of vessels, country of origin, and species fished.

weeks; south of Martha's Vineyard and Nantucket from mid-month. Moderate-to-heavy catches of herring and mackerel.

East Germany: 9 factory and freezer stern trawlers (45 in October 1969; 14 in November 1968). Principal catch probably herring.

West Germany: 4 freezer stern trawlers (28 in October 1969; 7 in November 1968). Herring was principal catch.

GULF OF MEXICO & SOUTH ATLANTIC

No fishing vessels reported.

OFF CALIFORNIA

No fishing vessels sighted. (One Soviet medium side trawler, 1 Soviet whale catcher en route to Peru, and 1 Japanese stern trawler in October 1969; 4 Soviet vessels near Channel Islands off Santa Barbara in November 1968.)

OFF PACIFIC NORTHWEST

USSR: 11 stern and 2 side trawlers, generally of Oregon from Cape Argo to Columbia River; 2 stern trawlers off Washington near Cape Flattery, Grays Harbor, and Cape Disappointment. (In November 1968, 20 vessels, including 14 stern trawlers.) Modest catches of Pacific hake. In mid-month, one catch by stern trawler off Columbia River estimated at 10,000 pounds.

Japan: 4 longliners off Washington; 2 longliners, 4 side trawlers, and 1 support vessel off Oregon. (In November 1968, 1 stern trawler and 3 longliners off Washington.) Longliners made good catches of 10" to 15" black cod.

OFF ALASKA (Fig. 2)

USSR: 31 vessels by month's end, 2.5 times number in October 1969, most since end of April 1969 (30-34 in November 1968). In November 1968, most fished ocean perch in Gulf of Alaska; remainder fished groundfish in Bering Sea. Distribution was reversed in November 1969; most fished groundfish in Bering, and rest fished ocean perch in Gulf.

By mid-month, 1 stern trawler and 3 medium trawlers exploring for herring north of Pribilofs, 2-3 weeks earlier than previous years.

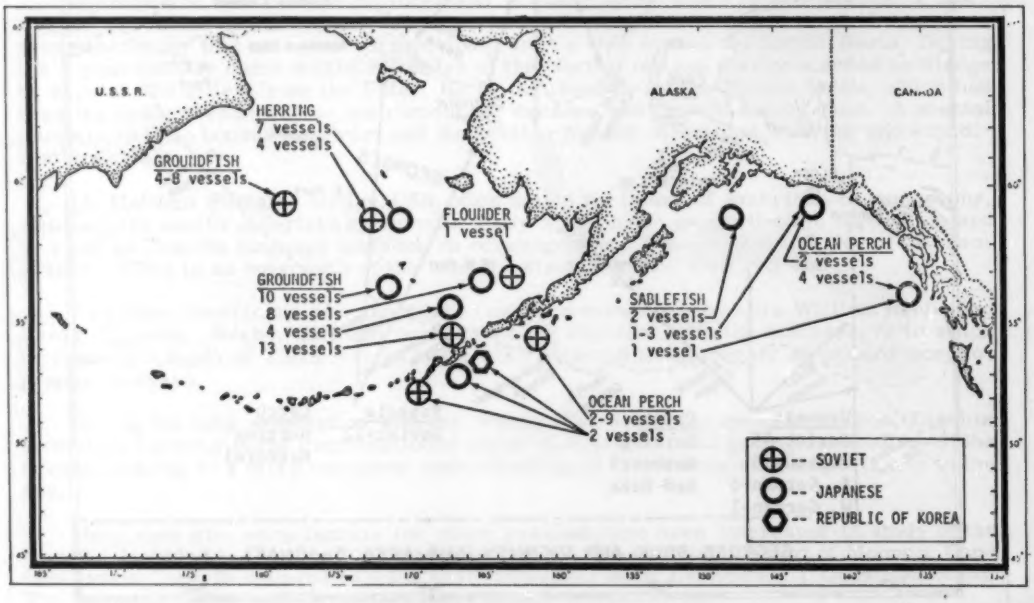


Fig. 2 - Foreign fisheries off Alaska, November 1969.

One medium trawler began flounder explorations in eastern Bering, on Continental Shelf north of Alaska Peninsula, 2-3 weeks earlier than previous years.

Japan: 40-45 vessels, about same as October 1969 (about 40 in November 1968).

By mid-month, 6 stern trawlers and 1 refrigerated transport, previously in groundfishery along Shelf edge, began fishing herring on Shelf north of Pribilofs, about a month earlier than in 1968.

Republic of Korea (South Korea): Late in month, 2 stern trawlers in Gulf, south of Unimak Pass. Catches presumably ocean perch, Alaska pollock, and other bottomfish. (South Korea's first fishing in Gulf since 1967.)

HOW ACCURATELY CAN OCEANOGRAPHERS PREDICT ICE FORMATION, SIZE, AND MOVEMENT?

The accuracy of ice forecasting depends on the locale, details required, time range of the prediction, and accuracy of the input weather information. Ice formation predictions are based on heat content and salinity of the water mass, currents, and expected heat exchange from water to atmosphere (weather prediction and climatology). The required heat, salinity, and current information is obtained by oceanographers aboard icebreaker survey ships when the ice coverage of the sea is at its annual minimum. From ocean data so obtained, the "ice potential" of the water can be determined.

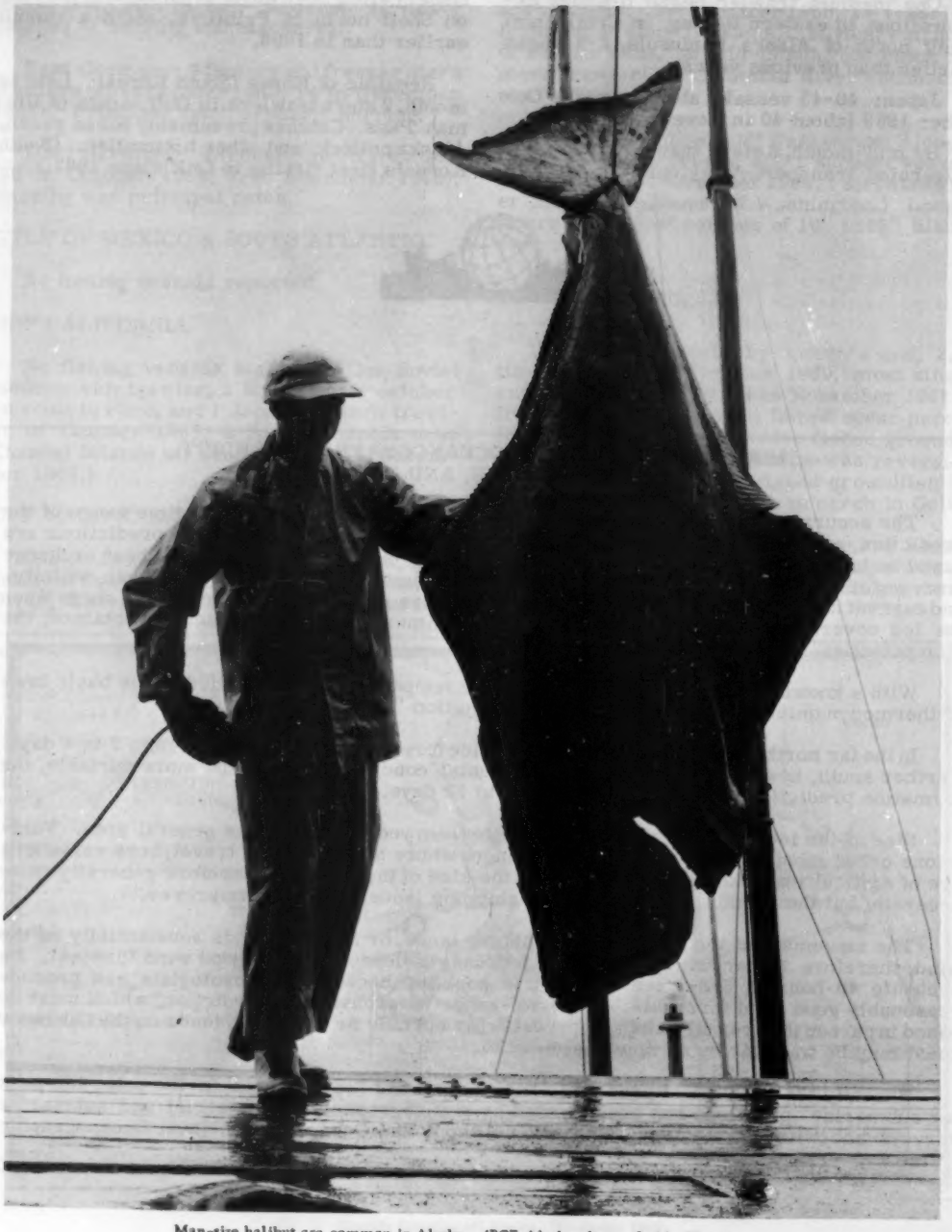
With a known ice potential and expected air temperature data applied to the basic laws of thermodynamics one can derive the ice formation "forecast".

In the far north, long-range predictions of ice formation are accurate within 2 to 4 days. Farther south, however, where the environmental conditions tend to be more variable, the formation predictions are accurate within 8 to 12 days.

Size of the ice pack varies relatively little from year to year in the general area. Variations occur mostly on the southernmost fringes where shipping must travel; here variations are of critical importance. Predictions of the size of the pack are therefore generally quite accurate, but the predictions of ice in the shipping lanes need to be improved.

The movement of ice in and out of shipping lanes, or leads, depends substantially on the wind; therefore the accuracy of an ice forecast is dependent on a good wind forecast. An accurate 48-hour to 5-day ice forecast is possible because meteorologists can produce reasonably good wind forecasts. For long-range (seasonal) ice prediction, which must be based in part on the area climatology, the dates for opening or closing of leads on the Labrador coast may be in error by as much as 6 weeks.

Recently the problem of predicting "heavy ice" and "open" areas in the polar ice pack for submarine operations has been tackled by oceanographers using aerial and submarine surveys and wind climatology. ("Questions About The Oceans," U.S. Naval Oceanographic Office.)



Man-size halibut are common in Alaska. (BCF-Alaska photo: J. M. Olson)

STATES

ALASKA

1970 KODIAK PINK SALMON RECORD RUN PREDICTED

"The Kodiak pink salmon forecast for 1970 is unique because it projects a record return for the even-year cycle," reports the Alaska Department of Fish and Game. Of further significance, the Department notes, the 1969 return has the highest odd-year run since 1939, although the parent year (1967) return was the poorest.

If 1970 forecast is substantially correct, Kodiak catch should approach 15 million. Also, a catch of 563,000 is projected for the Mainland District. This would mark first time since 1945 and 1946 that catches of successive years exceeded 10 million pinks. These catches are the estimates of the harvestable portion of a predicted run of 20.2 million fish.

Pre-Emergent Fry Densities

Forecasting would not be possible without a backlog of pre-emergent fry sampling data. The Department says a relationship exists between pre-emergent fry densities and later total returns. Hydraulic sampling of 31 major pink-salmon-producing streams in 1969 yielded the highest fry density in the 6 years of data collecting. "A ratio of the parent year pre-emergent fry density with the 1970 index for 29 comparable streams indicates the 1970 return at 20,200,000 pink salmon."

The Kodiak-Afognak Island 1970 forecasts of returns for the major districts are:

1. Afognak-Kizhuvak: The excellent fry densities in the streams indicate a 1970 return of 1.9 million pinks. Malina River should be primary producer.

2. Westside: The area from Outlet Cape to Rocky Point, including Terror, Uganik, and Uyak Bays, should contribute 3.5 million pinks.

3. Karluk-Red River: An exceptionally high fry density in Red River indicates near-record return of 6.3 million fish.

4. Alitak Bay: Fry densities were above parent-year index in all streams except Humpy River. Return is projected at 3.3 million pinks.

5. Eastside-Chiniak: Area from Monaska Bay to Cape Trinity should produce 5.2 million fish. Chiniak Bay should produce exceptionally strong return.

Chignik Area

The Eastern District, Chignik area (Kelokak Rocks to Kupreanof Point) is the primary pink-salmon-producing area in this cycle year. Parent escapements in Eastern District were good, and fry survival probably was normal. Good fry densities also were obtained in Western and Perryville Districts. Therefore, 1970 return is forecast above even-year average of 1.7 million.

* * *

SOUTHEASTERN PINK SALMON FORECAST FOR 1970

Of the 85 salmon streams sampled in Southeastern Alaska in 1969, 39 were in Southern half and 46 in Northern.

27.7 Million Pinks

In 1970, a run of 18.7 million pink salmon is expected to return to Southern Southeastern and 9 million to Northern Southeastern. Escapement indices for Southern area for 1964 and 1966 of about 5 million pinks produced returns of slightly over 20 million in 1966 and 1968. Escapement indices for northern area of 2 to 3 million in 1964 through 1967 produced highly variable returns of 5 to 12 million for return years 1966 through 1969. From this information, it is assumed that in 1970 about 5.5 million pinks will be allowed to escape to Southern Southeastern streams and 3.5 million to Northern streams. This would leave balance of 13.2 million in Southern and 5.5 million in Northern Southeastern available for harvest--a total Southeastern catch of 18.7 million pinks.

The Alaska Department of Fish and Game points out that this 1970 forecast is based on cumulative knowledge of the past 6 years' pre-emergent work in Southeastern Alaska.

* * *

EFFICIENCY OF SHRIMP POTS STUDIED

Fishermen in Southeastern Alaska have used shrimp pots (traps) for many years. In the past, the efficiency of shrimp pots was evaluated by catch analysis. This was indispensable for evaluation of fishing gear. However, direct observations answer some questions not apparent from other methods of analysis.

Aims of Study

The staff of BCF's Exploratory Fishing Gear Research Base at Juneau, Alaska, made the first use of the observational technique in studies of shrimp-pot efficiency. Shrimp pots were studied under controlled conditions in a large test tank at Little Port Walter, Alaska. One primary goal was to determine how shrimp escape from the pots. Another was to measure relative efficiency in terms of number of shrimp entering and escaping pots with different types of entrances.

5 Types of Pots

Shrimp pots with 5 types of entrances were used: short tunnel, long tunnel, top loader, ramp, and plastic pipe.

The long-tunneled pot was found most efficient type because fewer shrimp escaped from it than from all the others. Also, more shrimp entered it than either the ramp or top-loading pot. The ramp pot was least efficient: more shrimp escaped and fewer shrimp entered than pots with conical tunnels.

Details of these studies are in "Test-Tank Studies of Shrimp Pot Efficiency," by Doyne W. Kessler. The report is available from BCF Division of Publications, Bldg. 67, U.S. Naval Air Station, Seattle, Wash. 98115.

Fig. 1 - A husband and wife crew unloading day's catch of shrimp at a Wrangell, Alaska, processing plant.

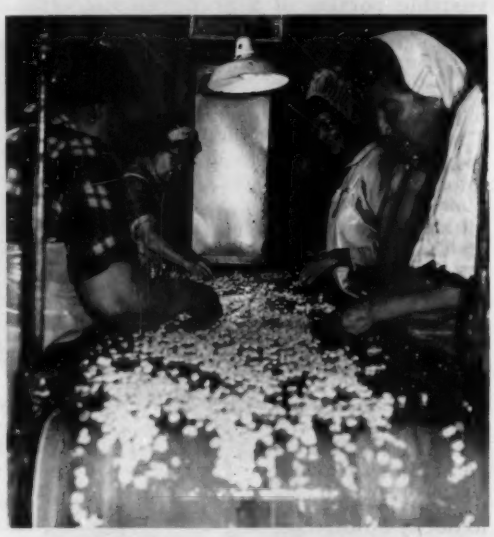
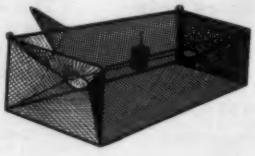


Fig. 2 - Shrimp from a peeler passes this team before being canned at a Wrangell, Alaska, processing plant.
(BCF-Alaska photos: J. M. Olson)



1969 SHRIMP & TANNER CRAB LANDINGS AT KODIAK SET RECORDS

The 1969 shrimp landings at Kodiak, Alaska, through November were 38.7 million pounds, a new annual record. It was an increase of 6.1 million pounds, or 19%, over 1968's record 32.6 million pounds.

The 1969 landings were made in 854 trips, or 40 trips fewer than comparable 1968 trips. Average catch per trip of 45,350 pounds in 1969 was 8,793 pounds more than 1968 average.

Tanner Crab Landings

Most Alaska Tanner crab landings are made in the Kodiak area. Through Nov. 1969, landings there were 6.7 million pounds--a rise of 4.2 million pounds, or 168%, over comparable 1968 landings.

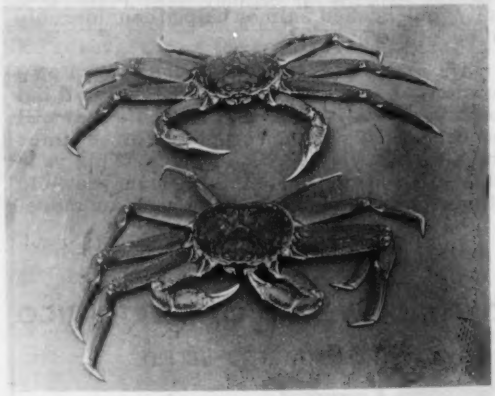


Fig. 1 - Male and female tanner crab.

Fig. 2 - A bucket load of tanner crab about to be placed in holding tank at a Kodiak, Alaska, processing plant.

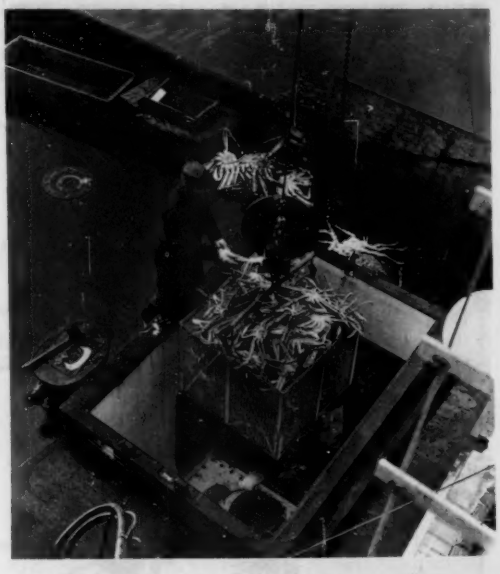


Fig. 3 - A bucket load of tanner crab being unloaded at a Cordova, Alaska, processing plant. Note larger king crab lying on deck.

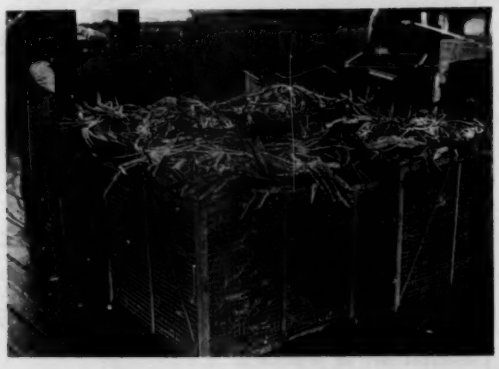


Fig. 4 - Tanner crab wait processing at a Cordova, Alaska, processing plant. (BCF-Alaska photos: J. M. Olson)

MASSACHUSETTS

APPRENTICE FISHERMEN WILL BE TRAINED BY BOSTON FLEET

The Boston fleet is setting up an apprenticeship training program. Men will be trained aboard large otter trawlers during 3 trips. The trawler owners will pay them $15 for an 8-hour day.

Fishermen's training program at New Bedford, Mass.

When the training is completed, the men will be ready to be signed on as full-fledged crew members.

MICHIGAN

RECORD SALMON CATCH IN 1969

Lake Michigan salmon fishermen set a record in 1969 by catching 175,000 cohos and chinooks weighing an estimated 2 million pounds. This was reported by the Department of Natural Resources. The catch was 75% above 1968's 100,000 fish. The Department says the increase reflects several plus factors:

(1) Bigger plants of cohos.

(2) The first substantial returns of adult chinooks: 43,000 of the total catch.

(3) More liberal regulations, including relaxed rule on foul-hooking.

(4) More "salmon savvy" by fishermen. Each year they come up with new and better techniques and tackle.

How Catch Divided

The total catch was about evenly divided between the open waters of Lake Michigan and tributary streams. In the streams, the rule permitting fishermen to keep accidentally foul-hooked salmon helped considerably to boost the harvest.

The Department of Natural Resources predicts that a record in 1970 seems all but certain. This is because the plants that will produce 1970's salmon crop were three times the size that yielded 1969's catch. This year also will see the first runs of four-year-old chinooks that may reach 40 pounds or more.

COMMONWEALTH OF PUERTO RICO

'STAHL' FINDS MARKET-SIZED FISH OFF SAN JUAN

Experimental fishing by the 'Agustin Stahl' has located productive grounds of silk, vermillion, and lane snappers. The grounds are in 35-45 fathoms directly east and west of the entrance to San Juan harbor. The vessel is operated by Puerto Rico's Department of Agriculture. Earlier, she found snappers and groupers between Vega Baja and Cerro Gordo.

The Catch

Production per pot was 10 to 40 pounds. Average size for the 3 species was $1\frac{1}{2}$ to 2 per pound. This is considered excellent market size for pan-fry fish.

The Department of Agriculture states: "Considering these results, it is apparent that many areas from Arecibo (north coast) eastward could be exploited commercially to a much greater degree than is presently done, specifically during the calmer summer season."

OYSTER CULTURE IN LONG ISLAND SOUND 1966-69

Clyde L. MacKenzie Jr.

The oyster industry in the Long Island Sound waters of Connecticut and New York (Fig. 1) is rapidly developing improved methods for raising oysters. Prospects are good for a return to production levels equaling or exceeding those of some earlier periods. The resurgence of the industry has resulted from determination of the causes of seed oyster mortalities, and the development and application of methods for preventing these mortalities. Future increases in production will probably be made through even more effective control of mortalities--and collection of much larger numbers of seed oysters as a result of better preparation of private setting beds and restoration of public seed areas.

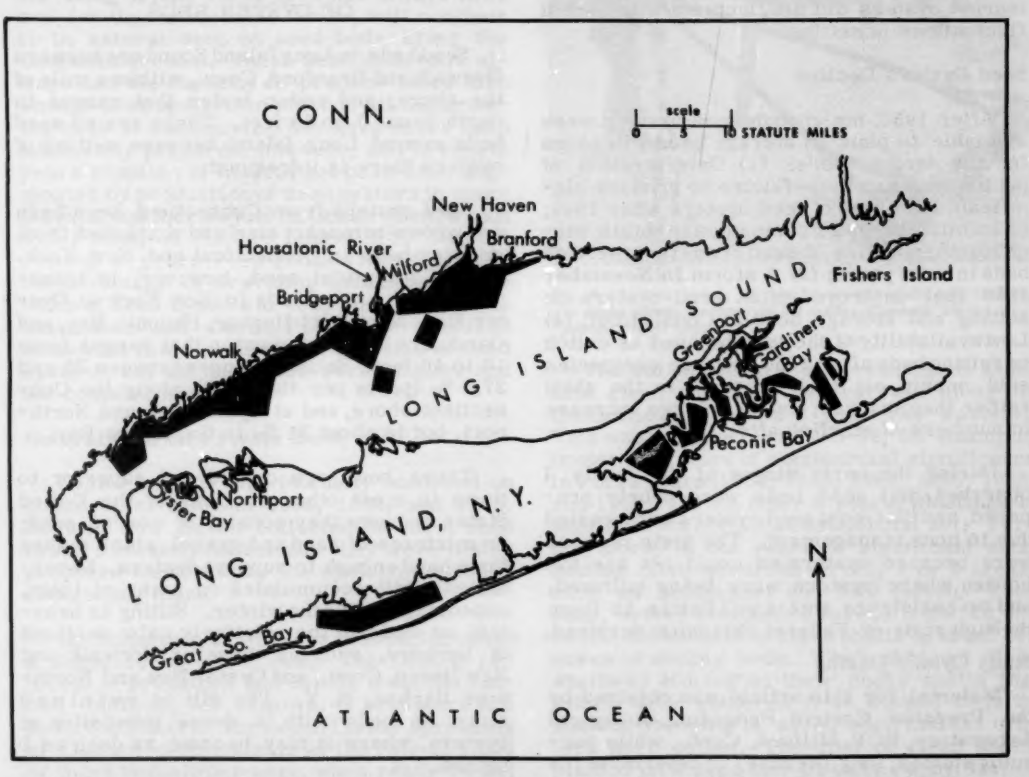


Fig. 1 - Chart of Long Island Sound showing coastlines of Connecticut and New York. Solid black areas show extent of oyster bottoms, only about 1 percent of which were actually planted with oysters in 1969.

The author is Fishery Biologist, BCF Biological Laboratory, Milford, Connecticut 06460.

U.S. DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Sep. No. 859

Production of oysters in the Sound declined sharply after the early 1950s from an average of about 1,300,000 bushels in 1950-52 to only 40,000 bushels in 1967 (Lyles, 1969). Traditionally, oyster companies held all their seed oysters on storage beds, totaling several thousand acres, under 30 to 50 feet of water in Connecticut. The quantity of these oysters was always several times larger than that marketed. Each year, a portion, depending on the size of beds and market demand, was transplanted to growing and fattening beds in Connecticut, but mostly in bays around Long Island. Companies merely filled vacant sections of storage beds when an oyster set occurred. Thus, the supply of market oysters did not fluctuate with annual fluctuations in setting.

Seed Oysters Decline

After 1950, not enough seed oysters were available to plant on storage beds. Reasons for the decline were: (1) Deterioration of public beds and their failure to produce significant quantities of seed oysters after 1948; (2) Inability of oyster companies to obtain significant quantities of seed from their private beds in most years; (3) A storm in November 1950 that destroyed most seed oysters on setting and storage beds in Connecticut; (4) Low availability of shells to be used as cultch on setting beds after 1950 because companies sold nearly all their oysters in the shell rather than shucked; and (5) A large increase in numbers of starfish after 1957.

During the early stages of this study, I observed that seed beds were poorly prepared, and that most seed oysters were wasted due to poor management. The main reasons were because oystermen could not see the bottom where oysters were being cultured, and no assistance was available to them through state or Federal extension services.

Study Oyster Deaths

Material for this article was obtained by the Predator Control Program, Biological Laboratory, BCF, Milford, Conn., while pursuing studies, long overdue, to determine the causes and patterns of mortalities of oysters on commercial beds.

The project involved: (1) Studying about 30 beds of oysters in Connecticut and New York by SCUBA diving once or twice a month; (2) Identifying causes of oyster mortality and determining the percentage killed by each cause at different periods; (3) Finding or developing methods for reducing the effects of these causes and other that limit production; and (4) Assisting oyster companies to fit better methods into their system of oyster culture.

Material was also obtained from extensive interviews with commercial oyster growers. Limited literature is available on any recent phase of oyster culture in Long Island Sound; most of this article consists of original material gathered from these sources.

LOCATION AND PHYSICAL CONDITION OF OYSTER BEDS

Seed beds in Long Island Sound are between Norwalk and Branford, Conn., within a mile of the shore, and under water that ranges in depth from 5 to 28 feet. There are no seed beds around Long Island because setting of oysters there is infrequent.

Seed oysters from Connecticut seed beds are grown to market size and marketed from growing beds in Connecticut and New York. Most Connecticut seed, however, is transported to growing beds in New York at Oyster Bay, Northport Harbor, Peconic Bay, and Gardiners Bay, under water that ranges from 10 to 40 feet. Salinity ranges between 25 and 27.5 ‰ (parts per thousand) along the Connecticut shore, and at Oyster Bay and Northport, but is about 31 ‰ in Gardiners Bay.

These beds are considered superior to those in most other sections of the United States because they consist of coarse sand, or mixtures of sand and gravel, which makes them hard enough to support oysters. Nevertheless, silt accumulates on many of them, especially during the winter. Silting is heaviest on beds in the relatively calm sections of harbors, such as those at Norwalk and New Haven, Conn., and Oyster Bay and Northport Harbor, N. Y. The silt is retained more on beds with a dense population of oysters, where it may become as deep as 2 inches.

Water temperatures over oyster beds are 32.5° to 33.5° F. from mid-January through mid-March. In Milford Harbor, Conn., average temperatures are:

Month	Temperature (°F.) 1/
Mid-January through mid-March	32.5 - 33.5
April	38.0 - 40.0
May	52.0 - 60.0
June	65.0 - 67.0
July	66.0 - 73.5
August	72.0 - 74.0
September	61.0 - 72.0
October	52.0 - 61.0
November	46.0 - 53.0
December	38.0 - 42.0

1/BCF records.

SOURCES OF SEED OYSTERS

The principal source of seed oysters in the Long Island Sound area has always been and, for the foreseeable future, will continue to be natural sets on seed beds along the Connecticut coast. These seed beds have always had the capacity to produce more than enough seed oysters to plant on all the growing beds of the Sound. They have never been adequately prepared, however, and in recent years supplies of natural set have been augmented by production of seed oysters in commercial hatcheries and in Ocean Pond, a salt water pond, on Fishers Island, N.Y. Natural setting, in years when goods sets occur, has the advantage of providing enormous quantities of seed oysters at very little cost. The hatcheries and Ocean Pond have produced somewhat more predictable supplies of seed oysters, but the quantities were smaller and the costs higher.

Natural Sets on Private Beds

Oyster sets of high intensity occurred on commercial beds in 1966, 1968, and 1969. Beds in New Haven collected the most seed oysters in each year because they were better prepared for setting by the oyster companies controlling them.

Optimum preparation of a seed bed involves a sequence of operations. The first is removal of predators and debris from the bottom (methods for removal of predators are described later). The second is the spreading of cleaned oyster shells at the rate of 1,500 or more bushels per acre, when ready-to-set oyster larvae become abundant in the water. In some areas, where silt begins to cover shells immediately, the third procedure is the removal of this silt, which can greatly reduce the number of spat obtained. To remove silt, oyster companies can use starfish mops, consisting of a metal frame about 12 feet long from which waste cotton bundles are strung, or cutting boards, measuring 15 feet long and 1 foot wide (Fig. 2). By use of these boards, which lift the silt when towed rapidly, a boat can flush silt from 25 to 50 acres of planted shells during each tide (MacKenzie, in press, 'a'). Companies employed starfish mops to a limited degree during 1968-69, but use of cutting boards for this purpose is a new development.

Fig. 2 - Cutting board, or vane, is towed rapidly over bottom, at angle shown, to scour silt off shells. Currents carry suspended silt off bed.

The old procedure of spreading all available clean shells on several beds along the Connecticut coast each year was wasteful. This was because from 1958-69, for example, oyster sets were of commercial significance in 6 of 12 years (1958, 1 69, 1962, 1966, 1968, and 1969). In the other 6 years, plantings of shells did not collect a commercial set. Furthermore, in the years of significant sets, setting often occurred in only 1 or 2 areas, such as Bridgeport and New Haven. Each year, oyster companies spread from 150,000 to 200,000 bushels of clean shells on about 175 acres of setting beds. They obtained clean shells by storing on their docks shells that either were gathered from unused beds by suction dredging or saved when market oysters were culled. The cost of clean shells planted on a seed bed obtained by section dredging was about 30 cents per bushel; that of culled shells was much less. So 200,000 bushels of planted shells cost about $55,000.

A common, but less effective, method for collecting seed is the dredging up and respreading of shells, covered with living organisms, that have been on a bed for a year

or more. Since this method does little more than expose small clean portions of shells that were laying against the bottom, it presents little additional clean surface where oyster larvae can set. During 1966-69, companies prepared about 100 acres of setting beds by this method.

In 1966 and 1968, several beds prepared with clean dock-stored shells caught as many as 15,000 spat per bushel of shells; in 1968, one bed (on which about 1,500 bushels of clean shells per acre had been planted) collected 50,000 spat per bushel. From this bed, about 2,500 bushels of seed per acre were harvested in spring 1969. At that time, the count of seed oysters had fallen to slightly more than 6,000 per bushel because of mortality and growth of oysters. In 1969, setting of oysters was not as intense; the best beds collected about 8,000 spat per bushel.

In 1968, the highest spatfall on beds prepared by the dredging up and replanting method was only about 2,000 spat per bushel of shells. Beds nearby prepared with clean shells collected from 3.5 to 12 times as many spat (MacKenzie, 'a'). Companies realized few seed oysters from these beds because they did not control starfish and oyster drills. In 1969, spatfalls on beds prepared in this manner were not of commercial intensity.

In 1968, MacKenzie observed that black shells obtained from muddy bottoms could be planted immediately and, being free of fouling organisms, would catch about as many spat as clean dock-stored shells.

Between 1966-69, more than 95 percent of formerly productive seed beds received no preparation. In those years, a small number of unprepared beds received light sets of only 100 to 200 spat per bushel of shells (MacKenzie).

The total quantity of seed oysters obtained from all privately owned beds was about 200,000 bushels in 1966, 300,000 in 1968, and 200,000 in 1969. About a third of the 1968 spatfall occurred on 2-year-old oysters (1966 generation).

Natural Setting on Public Beds in Connecticut

The decline of the Long Island Sound oyster industry was partly due to the relatively few seed oysters produced on public seed beds. The states of Maryland, Virginia, and Louisiana, which produce the largest quantities of oysters in the United States, depend on public beds as the source of most of their seed.

The once-famous Bridgeport-Fairfield public seed bed, 4,500 acres in size, has not collected a significant quantity of seed oysters since 1948 because it has not been adequately prepared. During 1966-69, the few shells on it were completely covered with fouling organisms, and oyster larvae could not set on them. Observations of oyster sets on clean shells in test bags placed on this bed by the BCF Laboratory at Milford indicate that the bed would have received commercial set in more than half the intervening years had it been properly prepared. In 1969, some interest was aroused to restore the bed's productivity.

The only commercial sets on public seed beds were in the Housatonic River in 1966 and 1968. The river had about 65,000 bushels of seed oysters in fall 1968, when about 4,000 bushels of mixed 1966 and 1968 seed were harvested from the river with hand tongs; this was only about 6 percent of the river's total quantity. One of my studies showed that about 75 percent of the remainder were suffocated by silt during spring 1969.

In 1969, a law was passed in the Connecticut Legislature that allowed the use of power to tow hand dredges on public beds. In the past, dredging could be done only by sailboats.

Hatchery Production of Seed

In 1968, 4 commercial hatchers on Long Island and 1 in Connecticut were producing seed oysters (Fig. 3). In the hatcheries, abult oysters are induced to develop ripe eggs and sperm before the normal spawning season by

Fig. 3 - Oyster hatchery at Bayville, Oyster Bay, Long Island, N.Y., is capable of producing 3,000 to 6,000 bushels of seed oysters a year. This hatchery began to rear spat as singles in 1969. Transparent roof and walls allow sunlight to reach tank cultures of algae.

keeping them in warm sea water for several weeks. When the oysters have developed ripe eggs and sperm, they are induced to spawn, and the fertilized eggs are placed in 100-gallon, conical-bottom tanks. These eggs develop into straight-hinge larvae within 48 hours and can be caught on fine Nitex[1/] screens as the water is drained from the tanks. Water is changed every 24 or 48 hours, and the larvae are resuspended in fresh sea water. When the larvae reach setting size, 10 to 20 days after fertilization, they are transferred to setting tanks in which a layer of shells has been placed as cultch.

When they were built during 1960-65, the hatcheries depended entirely on the algae present in raw sea water to feed oyster larvae. This water was pumped through centrifuges that removed silt, zooplankton, and the larger phytoplankton--but allowed smaller algae to pass through to large shallow tanks in a warm, lighted room with translucent roof. The water was held there for 24-48 hours to allow the small algae to increase in numbers before it was used to feed the larvae. Most commercial hatcheries now grow algae in special culture units (Davis and Ukeles, 1961) to supplement the natural algae of raw water, and they sometimes use cultured algae exclusively.

By using these techniques, each hatchery can produce 1,000 to 6,000 bushels of seed oysters with a count of 2,000 to 15,000 spat per bushel.

In 1968 and 1969, hatcheries developed techniques to produce single spat. To do this, they placed ready-to-set oyster larvae in 12-inch-diameter cylinders with a bottom of Nitex screening and a continuous flow of water. After 24 hours most larvae had attached to the sides and bottom. These post-set larvae were then washed off as singles, 1/70th of an inch long. These had to be grown in trays, with a fine screen bottom, suspended from rafts until oysters were large enough to be planted on the bottom (Butler Flower, personal communication).

The minimum size of single oysters to be planted on the bottom has not been established. MacKenzie made two observations of planted singles: If they are less than 1 inch long, they are washed about by currents as slow as 2 knots; they are susceptible to predation by the abundant mud crab, Neopanope texana, which does not prey on attached spat greater than $\frac{1}{4}$-inch.

Growing single oysters avoids problem of crowding oysters in clusters and of misshapen oysters; culling of market oysters will be easier because they will all be single.

Production of seed oysters in hatcheries has two major advantages: (1) A somewhat more predictable supply of seed oysters is available each year; and (2) New genetic strains of superior quality oysters can be propagated by hatchery methods if and when they are developed.

The two major disadvantages are: (1) Production of oysters (1,000 to 6,000 bushels per hatchery per year) is small compared to that from natural sets in good years (300,000 bushels in 1968); and (2) Cost of hatchery seed ($1.00 per 300 spat) is much higher than that of natural seed ($1.00 per 50,000 spat).

The annual cost of operating a hatchery ranges from 50,000 to 70,000 dollars.

Setting in a Salt Water Pond

Ocean Pond on Fishers Island produces about 10,000 bushels of seed oysters a year, about half sold to 2 oyster companies in Connecticut.

Clean scallop shells strung on wires hung from rafts collect the spat. Each raft holds 400 strings, and each string holds 75 shells. Just before the setting season, the water is sampled daily to determine the presence of ready-to-set oyster larvae. When they have become abundant, the shells are lowered into the water to receive them.

The rafts remain in the Pond until the following spring, when the number of oysters per shell averages between 10 and 30. In May, when the oysters are about 9 months old, companies remove the strings from the Pond, load them onto boats, strip off the oysters, transport them to the beds, and plant them.

GROWING OYSTERS FROM SEED TO MARKET SIZE

Culture Operations

In Connecticut, young-of-year seed oysters are sometimes transplanted from setting beds to growing beds in October, November, or December--but usually not until the following March, April, or May. Ordinarily, they are transplanted in the fall if the quantity of oysters is too large to move the next spring,

1/Mention of commercial products does not imply endorsement by BCF.

or if it is necessary to move them to beds more protected from starfish invasions or winter storms.

Growing beds are cleaned of predators, such as starfish and oyster drills, competitors, such as slipper shells and mussels, and silt before seed oysters are spread. Seed oysters may be transplanted each spring thereafter, or, if not transplanted, thinned out. Companies that do not transplant or thin out growing oysters each year find that they become much too dense on the bottom--in some instances, more then 3,000 bushels per acre. If a significant percentage of seed oysters is covered by silt, which accumulated during the winter, or by sand during winter storms, they must be transplanted during the following March or early April before water temperature reaches about 43° F. (the level at which most begin active pumping), or the buried ones suffocate (Fig. 4). When seed oysters are in clusters, repeated transplanting each year also breaks these apart so that almost all oysters are "singles" by the time they reach market size. A portion of market oysters may be attached in clusters, however, if the original set of seed oysters was very heavy. Most oysters are transplanted 3 or 4 times before they reach market size.

During 1966-69, oyster companies spread seed on growing beds at lower concentrations than they had in the past. They spread 1-year-old 1968 set on growing beds at rates of 175 to 300 bushels (750,000 to 1,000,000 oysters) per acre, depending on number of individuals per bushel. In the past, the rate of spreading of 1-year-olds was 500 to 800 bushels per acre. But survival rates of oysters became much higher, so spreading rates had to be lowered to accommodate growth of the

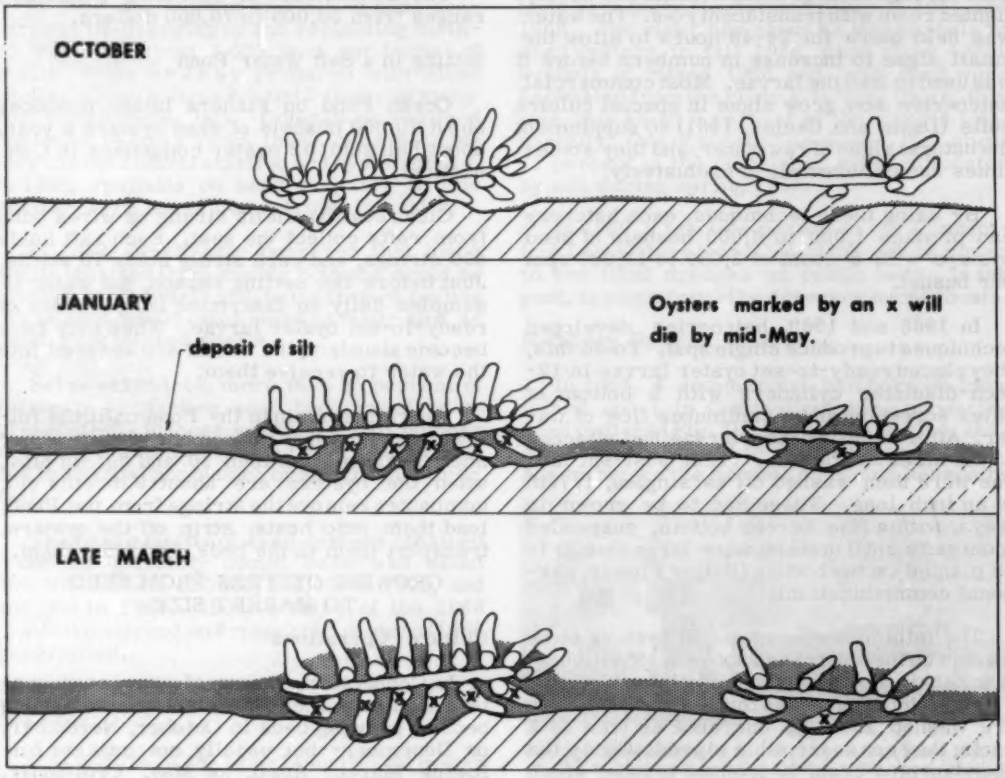


Fig. 4 - Schematic diagram showing deposit of silt around clusters of small oysters during 3 months. Oysters covered by silt suffocate during late April and May.

oysters. A planting of oysters of this age increases 4 to 7 times between April and December. At higher rates of spreading, the concentration of oysters by December, when growth ceased because of cold water temperatures, was greater than 1,500 bushels per acre--too many for high survival and good growth. When the oysters were 2 years or older, they were spread at rates of 300 to 500 bushels per acre. Even though spreading rates of oysters were lower, most growing beds had too dense a population of oysters in 1968-69.

Oysters are usually marketed at 4 to 5 years when 200 to 250 constitute a bushel. During 1966-69, companies sold many oysters 3 years old. Older oysters were in short supply. In fall 1969, however, about 2,000,000 bushels of oysters of various ages were growing on 2,000 acres of bottom in Connecticut and New York.

The total cost of producing a bushel of market oysters, including rental of beds, procurement of seed, control of starfish and oyster drills, use of boats to clean beds and to transplant seed and harvest market oysters, and culling, averages about $2.50. The cost of culling, $1.25 average ($0.60 to $4.50 range) per bushel, is as high as all other expenses combined (Fig. 5). In 1969, oyster companies received as much as $18 per bushel for market oysters. Since the early 1950s, most oysters have been sold unshucked for the half-shell trade.

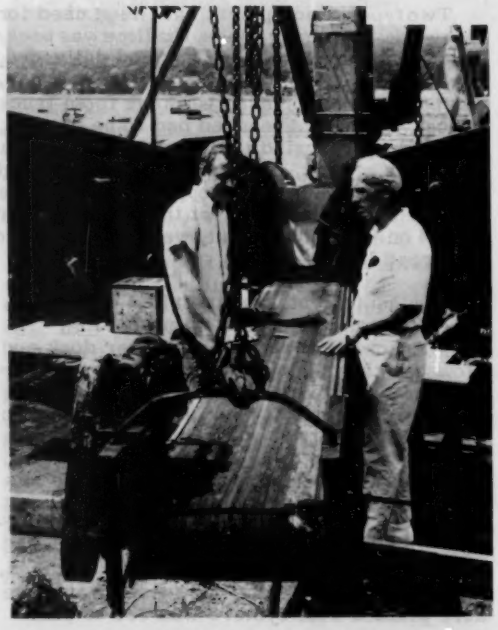


Fig. 5 - Oysters are culled faster and more cheaply from moving conveyor belt than from culling bench.

Equipment to Transplant & Harvest Oysters

A typical oyster boat in Long Island Sound is equipped with 2 standard oyster dredges: each can be lifted out of the water and over the boat's deck by a boom (Fig. 6). At the bottom of each dredge is a hinged door, which unlatches to empty the oysters on deck. The crew of a boat consists of a captain and usually 2 (sometimes only 1) deckhands. The boat plants, transplants, and harvests oysters. To plant seed oysters, two 4-inch-diameter hoses are used to wash them overboard while the boat travels at fairly high speed to ensure good spreading. The cost of operating an oyster boat is about $100 per day. Since a boat can transplant or harvest for market about 1,000 to 2,400 bushels of oysters per day, the cost is 4 to 10 cents per bushel.

Fig. 6 - Transplanting boat partially loaded with seed oysters. Booms are used to lift dredges over the deck. After boat is loaded, seed oysters are washed overboard on growing beds by hosing with water under low pressure. Cost of transplanting seed oysters ranges from 4 to 10 cents per bushel.

SCUBA divers (Fig. 7) observed oyster dredges being towed over the bottom. They found that the teeth, which are about 4 inches long, were perpendicular to the bottom. As a result, only 10 to 20 percent of the oysters in the dredge's path were gathered. The dredge had to be towed rapidly to gather oysters because of the tooth angle. This caused the breaking and killing of a significant percentage of seed oysters (Medcof, 1961;

Fig. 7 - SCUBA diver entering water to inspect conditions on oyster bed. Depth of water is about 15 feet.

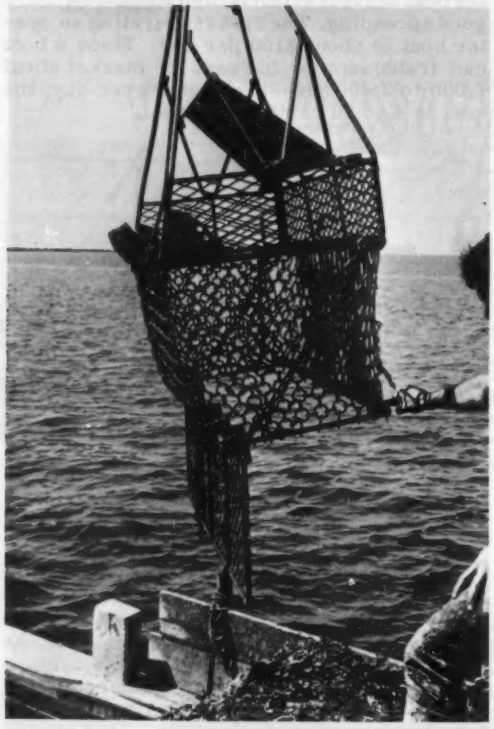


Fig. 8 - Oyster dredge with teeth angled forwards, to pass under oysters laying on bottom. Hinged door at bottom of dredge unlatches to release load of oysters.

Quayle 1969; MacKenzie). The dredges were modified.

The new dredges are built with the teeth pointing forward at a 15° angle in relation to the bottom (Fig. 8). These dredges have some advantages: (1) They can be towed at about half the speed used to tow old dredges, (2) They fill more quickly, (3) Less chain or cable is required to tow them, (4) Nearly all the oysters are gathered from the bottom during each pass, and (5) Apparently, they are less destructive to seed oysters.

Controlling Starfish

Some boats are equipped to control starfish. They are rigged with 2 mops and 2 tanks filled with water near the boiling point. Mops are dragged over the bottom for 10-minute periods and then dipped into the tanks to kill the starfish that have been collected. Boats so equipped can remove scattered starfish from beds more cheaply than by using lime. These boats are also equipped with either lime hoppers or tanks and water hoses to spread quicklime over beds infested with starfish.

Two types of equipment have been used for this work. For many years, the lime was packaged in 80-pound paper bags and delivered, perhaps 500 bags at a time, by cargo truck. The bags were carried by workers from truck to boat. When boat reached bed to be treated, the workers carried the bags to hopper on each side of boat, cut open bags, and poured lime into hopper. The hopper fed the lime into the stream of water at the bottom. Eight men, 4 on each side of boat, were often needed to spread lime.

New equipment, now installed on 2 boats, makes it possible to handle lime in bulk. The cargo truck delivers lime to oyster dock and blows it by air through a pipe into large storage tank, capable of holding 30 tons, at edge of dock. From this tank, the lime is blown by pipe into the tank on the boat, which holds 12 to 15 tons (Fig. 10). When a bed is treated, only 1 worker is required on deck. All he has to do is start water pump and open doors at bottom of lime tank. This system works efficiently; the cost of lime is lowered from $26 to $21 per ton because no bagging is required. The annual cost of lime for treating average acre planted with oysters was $21 to $42.

Presently, about 15 oyster-dredging boats work in Long Island Sound. Four others are

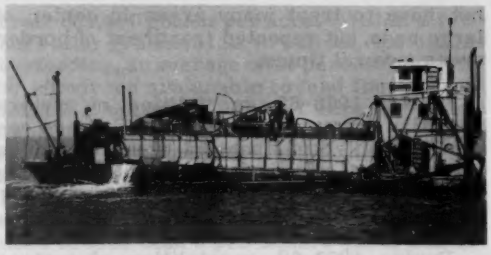


Fig. 9 - Suction dredging system mounted on barge is used to harvest shells to be used as cultch and to remove oyster drills from oyster beds.

Fig. 10 - Spreading quicklime to kill starfish which invaded oyster bed. Tank on boat holds 15 tons of quicklime.

used exclusively to control starfish, and 2 boats and a barge are equipped with suction dredges. The boats are 55 to 85 feet long. The barge (Fig. 9) can dredge up 10,000 bushels of buried shells from the botttom, or remove oyster drills from 1 to 2 acres of bottom a day.

Causes of Oyster Mortality, 1966-69

The most important cause of mortality of oysters was starfish, Asterias forbesi. A single starfish can consume several oyster spat simultaneously. On beds where starfish were numerous, more than 1 per square yard, they reduced good sets of oysters to non-commercial levels within a few weeks; even on beds where good starfish control was practiced, up to 94 percent of spat were killed in bands 15 to 20 feet wide along borders of beds (MacKenzie). The rate of feeding on 1-year-olds has not been determined, but MacKenzie (1969) observed that a starfish can consume as many as five 2-year-old oysters per 28 days.

Silt

The second most important cause of mortality was silt. This settled over beds during winter, and suffocated seed oysters in late April and May when water temperatures rose above 43° F. (Fig. 4). Silt may accumulate to 2 inches by late March in areas where currents are low and wave action is slight. In open waters, where currents are strong or wave action generated by storms disturbs the bottom, silt deposit is usually negligible. In the Housatonic River, a protected area, 75 percent of about 65,000 bushels of 1- and 2-year-old oysters were suffocated by silt in spring 1969. In calm sections of harbors, such as New Haven, the mortality of 1-year-olds due to suffocation was 50 percent. In a more open area of that harbor, it was about 15 percent in spring 1968. Oystermen and biologists formerly termed this cause of mortality "winter kill." They believed it was caused by prolonged low temperatures.

Older-Type Oyster Dredge

The third most important cause was the use of the older-type oyster dredge in transplanting seed oysters. When 3-month-old spat were transplanted, about 15 percent were mechanically broken and killed. In addition, on beds where a large proportion of spat was attached to small fragments of shells, about 20 percent were left behind by the dredges. Usually, these were not protected thereafter and were killed by starfish (MacKenzie). Besides damage to young-of-year oysters, between 3 and 5 percent of 2-year-olds were killed by dredges during transplanting. MacKenzie estimated that if mortalities of seed oysters could be reduced to zero during transplanting, production of market oysters would increase about 50 percent.

Oyster Drill

The fourth most important cause was the oyster drill. In most sections of Connecticut (except for New Haven Harbor), in Oyster Bay and Northport Harbor, the thick-lipped drill, Eupleura caudata, is more common than the Atlantic oyster drill, Urosalpinx cinerea (MacKenzie, in press, 'b'). A single drill can consume at least 10 spat a month, and 18 to 20 one-year-old oysters, between late April and late November. Because drills were

under good control by oyster companies, mortality of spat and older seed oysters caused by them was small during 1967-69. The heaviest mortality of spat by oyster drills observed on any bed in 1968 was 25 percent between setting and late November.

Mud Crab

The mud crab, Neopanope texana, was the fifth most important cause. It destroys spat up to $\frac{1}{4}$-inch long. In 1968, it appeared to me that 5 to 15 percent of spat were killed by mud crabs. On 1 bed, however, they killed more than 50 percent.

Mortality of oyster spat also resulted from other causes: overgrowth by slipper shells (double deckers), Crepidula plana and Crepidula fornicata; calcareous (lace) bryozoans, Schizoporella unicornis; jingle shells, Anomia simplex; and barnacles (species not identified). Mortalities from these causes were small--estimated at about 15 percent of spat on typical bed in New Haven Harbor in 1968. On 1 bed, however, where slipper shells were extremely numerous, they alone killed about 60 percent of spat before age of 2 months in both 1968 and 1969. Rock crabs, Cancer irroratus, may also kill small oysters.

I also found additional causes of mortality of older seed oysters: burial during winter storms, predation by whelks and, apparently, some very old oysters were killed by infestations of boring sponges. Also, 3 to 9 percent of oysters 2 years and older died after spawning in 1968.

There is no evidence that mortalities of oysters in Connecticut were attributable to MSX or other diseases.

Controlling Predators & Other Causes

Oyster companies have starfish under adequate control. They use mops to determine their location; if significant numbers (more than 10 starfish per mop frame per 3-minute tow) are found on the border of, or near a bed of oysters, they spread quicklime over bed during next period of slack current, at rate of about 2,000 pounds per acre. Starfish stop feeding instantly and die soon thereafter. Only those starfish protected underneath shells or algae survive liming treatment. During 1967-69, companies spread lime on beds planted with oysters on average of once or twice per acre per year. In practice, companies did not have to treat many areas in center of large beds, but repeated treatment of border areas several times.

During 1968-69, mortalities of oysters resulting from suffocation by silt were reduced to only about 2 percent when companies transplanted oysters to growing beds during March and early April, rather than waiting until traditional May and June.

During 1968-69, mortalities of oysters from transplanting operations were reduced somewhat by modification of tooth angle of oyster dredges, and by transplanting spat as late in the fall as possible to allow them to grow larger and thicker shells. But even the modified dredges kill many seed oysters.

Polystream

Most oyster companies now employ suction dredges or Polystream (Granular) to keep oyster drills under control (Fig. 11). Suction dredges can remove most drills from 1 to 2 acres of bottom per 8-hour day. Polystream (Granular), approved by U.S. Department of Agriculture for commercial use to control oyster drills in Connecticut and New York, is spread evenly over surface of the water, with the same equipment used to spread lime,

Fig. 11 - Pouring clay granules saturated with Polystream into hopper from which they will be hosed overboard. As the granules sink, they spread evenly over the bottom and kill 85 percent of oyster drills within 4 weeks.

at rate of 1,600 pounds per acre. Within a few hours after granules fall to bottom, the drills stop feeding, an average of 85 percent die, and the survivors are unable to feed for several months. The cost of treating 1 acre of bottom is about $200. The bottom remains relatively free of drills for at least 5 years; a treatment averages no more than $40 a year. By using either suction dredges or Polystream (Granular), the number of drills on a bed can be reduced to less than 2 per square yard; this is a density which cannot cause significant damage to seed oysters. Polystream (Granular) treatments should be made in late April or early May because they kill fewer drills when made later in the season. I also found that treatment of bottom with quicklime in heavy concentrations will control oyster drills.

Of about 2,000 acres planted with oysters in fall 1969, oyster companies had to control oyster drills on about 400 acres. The remaining areas, not planted with oysters for many years, did not have drills. Control of drills was achieved by suction dredging on about half the infested area, and by treatment with Polystream (Granular) on the other half.

No specific attempt has been made to control mud crabs, but most are removed incidentally when beds are cleaned by suction dredges or by standard oyster dredges before cultch or seed oysters are planted.

The fouling organisms that cause spat mortalities are controlled partially by delaying planting of cultch on setting beds until oyster larvae are ready to set. This avoids the competitors and fouling organisms that set earlier.

ESTIMATES OF POSSIBLE OYSTER YIELDS

Development of new predator-control methods, avoidance of mortalities from smothering, and better surveillance of beds to detect invasion by predators and accumulations of silt--have resulted in large increase in survival rates of seed oysters and consequent yields, with promise of greatly increased production of market oysters.

In one example, a company planted 1,000 bushels of 1-year-old oysters, counting 6,000 per bushel, in May 1966. I counted a natural set of 9,000 spat which attached to each bushel of these 1-year-olds in July 1966. Oyster drills had killed 40 percent of these 2 groups by mid-August. The company treated bed with Polystream (Granular) on August 24, and this prevented further mortalities from drills. Some 6,000 bushels of oysters were transplanted off this bed in May 1967, a sixfold increase; these oysters had increased to 15,000 bushels by May 1968. I estimated the volume at 20,000 bushels by late fall 1969. Had the bed been treated with Polystream (Granular) earlier than August 24, the final yield would have been considerably larger. This production is far superior to past yields, which averaged only 1 bushel of market oysters from 1 bushel of 1-year-old oysters.

Since all phases of the much improved system of caring for seed oysters had not been practiced before 1966, no oysters that had this intensive care had reached market size by fall 1969. The following percentage survival estimates are based on studies of different beds of different ages that had the most intensive care during study period:

Age of Oysters[1]	Percentages of Survival Recorded		Number of Beds Studied
	Average	Highest	
Setting to 1 mo.	60	85	15
1 mo. to 9 mo.	75	90	18
9 mo. to 1 yr. 9 mo.	80	90	13
1 yr. 9 mo. to 2 yr. 9 mo.	85	94	7
2 yr. 9 mo. to 3 yr. 9 mo.	93	95	7
5 yr. to 6 yr.	90	90	1[2]

1/Oysters of age 3 yr. 9 m. to 4 yr. 9 mo. were not studied.
2/Estimate made from 100 oysters held in tray on bottom.

From these average percentages of survival, and assuming a 90 percent survival from 3 yr. 9 mo. to 4 yr. 9 mos., the following yields of certain ages can be expected:

One bushel of 1-month-old spat, counting 10,000 per bushel, will yield about 21 bushels of market oysters (200 oysters per bushel).

One bushel of 9-month-old seed (1-year-olds), counting 6,000 per bushel in April, will yield about 18 bushels of market oysters.

One bushel of 1 year 9-month-old seed (2-year-olds), counting 700 per bushel in April, will yield about 2.5 bushels of market oysters.

One bushel of 2 year 9-month-old seed (3-year-olds), counting 400 per bushel in April, will yield about 1.7 bushels of market oysters.

In summer 1969, many beds were planted with seed oysters maintained under intensive care. If, from time of 9 months, 40 to 50 percent should survive to market size, they

will yield 5 to 30 bushels of market oysters for each bushel planted.

SIGNIFICANT DEVELOPMENTS SINCE 1966 THAT MADE HIGHER YIELDS POSSIBLE

The most important factors in bringing about the remarkable increase in yields, and the promise for much greater increases in yields and in total production in the future, were: (1) Systematic identification of causes that limited production; (2) Monthly counts of living and dead seed oysters on many beds, which established relative importance of these causes; (3) Use by most companies of superior methods, previously employed by only 1 or 2 companies; (4) Introduction of new methods; and (5) The speed with which oyster companies adopted these methods to overcome or minimize effects of these limiting causes.

The use of SCUBA diving techniques was instrumental in determining the causes of oyster mortalities and the effectiveness of remedies. Divers can observe conditions as they actually exist on a bed. By quantitative sampling techniques, they can determine precisely when predators, accumulations of silt, and burial by storms endanger a bed. Divers found that deposits of silt on shells significantly interfered with setting of oysters. They found that companies often planted seed oysters in scattered, too-dense patches, rather than uniformly over bottom. By using divers, incorrect estimates of the situation on beds are avoided, the efficiency of culturing oysters can be sharply upgraded, and oyster companies can avoid many management errors.

PROBLEMS THAT NEED TO BE SOLVED

It has been estimated that the enormous number of ready-to-set larvae in Connecticut waters from July to October 1968 would have yielded up to 500,000,000 bushels of market oysters if--sufficient shells of good quality had been provided to catch them; they had been protected from predators, competitors, and suffocation; enough equipment had been available to handle them; and sufficient space had been available to grow them. At most, only 0.4 percent of this potential will be realized since the total 1968 set saved will grow into about 2,000,000 bushels of market oysters.

The following problems must be solved before oyster companies will be able to obtain larger percentage of the potential from a crop of larvae.

Seed Beds Need Better Preparation

Companies must prepare their seed beds better to increase the number of oyster spat obtained. They should store larger quantities of shells on their docks. These shells should be spread on beds only in years when oyster larvae set, and only in areas where the larvae are present (extensive sampling of larvae would be required to do this). After the supply of shells on their docks has been planted, black clean shells dredged from under the bottom should be harvested and planted on setting beds. Silt should be removed from setting beds. Also, larger quantities of shells per acre, perhaps up to 3,000 bushels, should be planted, experimentally at first. My recent observations indicate that filter feeders, such as clams, oysters, and mussels, should be removed from a setting bed because they may reduce setting by ingesting oyster larvae.

The Bridgeport-Fairfield public seed bed should be restored to full production as an additional source of seed oysters by a good management plan. Clean shells should be spread on the bed, and starfish should be controlled. Oyster drills are uncommon on the bed.

Seed Oysters Require More Care

To raise a higher percentage of seed oysters and to increase yields even further, companies need to give them more care. Accordingly, I am attempting to develop methods for reducing mortalities and to determine the optimum levels of care seed oysters require.

More Efficient & Specialized Equipment Needed

The standard oyster dredge is used to perform nearly all tasks in oyster culture, including: (1) Transplanting seed oysters; (2) Harvesting market oysters; (3) Recovering shells from setting beds to be replanted; (4) Sampling oysters to determine their condition; and (5) Even checking beds for the presence of starfish.

This dredge was used to harvest oysters since the 1800s and was still employed in the late 1960s with little significant change in design. It is grossly inadequate to perform any of these tasks for the following reasons: (1) It loads a boat at the slow rate of only 300 to 500 bushels per hour or, at most, 2,400 bushels a day. (Actually, it harvests oysters from

the bottom only 5 to 7 percent of the time); (2) It kills too many spat and larger seed and leaves too many behind on a bed; (3) It takes inadequate biased samples of oysters from the bottom to determine their condition; and (4) It covers too little area when used to check beds for the presence of starfish.

Because of a short supply of boats, a great need exists for a harvester that will load a boat or barge with seed (with less breakage) or market oysters much faster. A harvester that could remove all spat from a bed probably would also remove enemies from the bottom--such as starfish, oyster drills, mud crabs, and slipper shells. The Bailey hydraulic-escalator oyster harvester used on the Pacific Coast (Quayle, 1969), or the Chesapeake Bay escalator clam harvester modified to harvest oysters in Eastern Canada (Medcof, 1961), would probably satisfy these requirements. But these harvesters would have to be modified to retain small predators and to function on beds under the deeper waters of Long Island Sound (MacKenzie).

Most seed beds have at least 1,000 and many more than 5,000 bushels of shells per acre buried under the bottom. A device such as a wide agricultural cultivator with deep-penetrating, curved, rigid tines could be towed to raise the buried, but clean, shells to the surface. Silt might have to be flushed off these raised shells afterwards. Uncovering these shells would greatly expand the area available for a set of oysters.

Many unused seed beds have more than 1,000 bushels of shells per acre on the surface of the bottom. These shells are virtually useless as cultch for setting oyster larvae, however, because they are covered with fouling organisms. BCF is trying to develop a method for killing these organisms before oyster setting. If this can be done, the area available for a set of oysters would be greatly expanded.

Silt can be removed from a setting bed effectively by use of starfish mops or cutting boards. The design of both, however, can be improved. The starfish mop could be constructed wider than 12 feet, and the cutting board could be constructed so not to disturb sediments under planted shells. I found that most silt on shells originates from the bottom directly beneath the shells. The quantity of silt in bottom sediments varies widely. For this reason, a cutting board that scours the bottom vigorously might stir up additional silt and worsen the condition of the shells on some beds. A cutting board that could be towed at predetermined distances above the bottom might remove silt from shells without disturbing the bottom, regardless of its consistency.

A device such as a wide agricultural cultivator with shallow-penetrating, curved spring tines needs to be used to recover oysters buried by storms. Divers have found that oysters are seldom buried more than an inch under the bottom; recovery should be easy. Oysters buried by storms have always died because companies have never attempted to recover them.

The cost of labor for culling oysters is much too high. A system such as a conveyor belt with holes, and with a side-to-side motion to separate oysters from small empty shells and stones, could be used to lower this cost.

CONCLUSION

The level of efficiency of oyster culture in Long Island Sound increased sharply during 1966-69. Undoubtedly, it will continue to increase because the differential between the cost of producing oysters and the selling price is extremely wide. Companies will make large profits on any oysters sold. New developments are needed to increase the quantities of oysters available.

ACKNOWLEDGMENTS

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LITERATURE CITED

DAVIS, HARRY C. and RAVENNA UKELES
1961. Mass culture of phytoplankton as foods for metazoans. Science, vol. 134, no. 3478, pp. 562-564.

LYLES, CHARLES H.
1969. Historical catch statistics (shellfish). U.S. Fish Wildl. Serv., C.F.S. no. 5007, 116 pp.

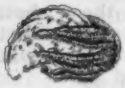
MacKENZIE, CLYDE L., Jr.
1969. Feeding rates of starfish, Asterias forbesi (Desor), at controlled water temperatures and during different seasons of the year. U.S. Fish Wildl. Serv., Fish Bull., vol. 68, no. 1, pp. 67-72.

(in press, 'a'). Causes of oyster spat mortality, conditions of oyster setting beds, and recommendations for oyster bed management. Proc. Natl. Shellfish. Assoc.

(in press, 'b'). Control of oyster drills, Eupleura caudata and Urosalpinx cinerea, with the chemical, Polystream. U.S. Fish Wildl. Serv., Fish Bull.

MEDCOF, J. C.
1961. Oyster farming in the Maritimes. Fish. Res. Bd. Can., Bull. no. 131, 158 pp.

QUAYLE, D. B.
1969. Pacific oyster culture in British Columbia. Fish. Res. Bd. Can., Bull. no. 169, 192 pp.



WHAT ARE ALGAE?

Algae are primitive plants ranging in size from a single cell, which can only be seen with a microscope, to the giant kelps, which grow to a length of 100 feet. Algae are dominant in the sea, both in number of species (approximately 6,600) and in number of individual plants. Although algal cells contain chlorophyll and other pigments, these plants do not have roots, stems, or leaves. However, some larger forms do have structures which resemble these organs.

Algae do not need roots, because they live in a solution of nutrients and the whole plant can absorb water and nutrients from this solution. Some algae have a holdfast that resembles a root. The holdfast is simply a structure that holds the plant in place; it does not absorb water or nutrients from the "soil"; therefore, it cannot be called a root. Since most of the plant can absorb materials needed for sustenance and growth, there is no need for an elaborate system to transport water, nutrients, and food; therefore, algae do not have stems. The supporting structure of kelp that resembles a stem is called a stipe; it does not serve a transport function and it does carry on photosynthesis.

Some algae have blades that resemble leaves, but these are extensions of the plant body and are not the primary site of photosynthesis as in terrestrial plants. Because the entire body of the algal plant carries on photosynthesis, the blades are adapted to increase the surface area to make absorption and photosynthesis more efficient.

Photosynthesis requires light, and, since the amount of light available in the water is limited by suspended particles, the blades with their larger surface area enable the algae to receive more of the available light. When the water is very turbid, light penetration is poor and plants grow only in shoaler areas. Plants with large surface areas have a better chance of survival.

Large plants do not usually grow in the open ocean, but are restricted to water less than 300 feet deep; one exception is the sargassum weed which floats in the surface layers of the Sargasso Sea. Algae in the open ocean are generally one-celled forms and are limited to the lighted zone (surface to approximately 600 feet). These algae are extremely numerous and are referred to as the "grass of the sea" because they are the very beginning of the food chain in the sea. ("Questions About the Oceans," U.S. Naval Oceanographic Office.)

SNAPPERS OF THE WESTERN ATLANTIC

Luis R. Rivas

This paper is based on observations obtained during 18 years (1950-68) of exploratory fishing by the U.S. Fish and Wildlife Service and the BCF Exploratory Fishing and Gear Research Base at Pascagoula, Miss. The data may be readily retrieved by the Base's UNIVAC 9200 computer.

In this study, information is presented on the geographical, depth, and temperature distributions of the 11 species of Lutjanus that occur in the western Atlantic.

L. analis	Muttonfish or mutton snapper
L. apodus	Schoolmaster
L. buccanella	Blackfin or hambone snapper
L. campechanus	Gulf red snapper
L. cyanopterus	Cubera or Cuban snapper
L. griseus	Mangrove or gray snapper
L. jocu	Dog snapper
L. mahogoni	Mahogany snapper
L. purpureus	Caribbean red snapper
L. synagris	Lane snapper
L. vivanus	Silk or yelloweye snapper

Throughout this paper the species will be referred to by common name with the word 'snapper' omitted.

For keys, descriptions, and figures serving to identify species of snappers, see Rivas (1949; 1966), Anderson (1967), and Randall (1968: 120).

The exploratory work of the Pascagoula Base extends from Cape Hatteras, N.C., to the bulge of Brazil (Fortaleza). Because these snappers are tropical and subtropical, horizontal distribution is adequately covered. Throughout this area, 2,809 stations were occupied during the 18-year period that yielded species of Lutjanus. Only the Gulf red was collected north of Cape Fear, N.C.

The species of Lutjanus are essentially bottom fishes, so we have considered only bottom-sampling gear and bottom temperatures. Bottom temperatures were not always taken this way, thus there are few or no records for some species.

The vertical coverage, which extends from 2 to 2,685 fathoms, is considered adequate, except perhaps for species such as the mangrove and cubera in the very shallow waters of estuaries. However, the mangrove was recorded from 102 stations; the cubera from only 3. Figure and Table 1 show the preferred depth for the mangrove as 17 to 27 fathoms, despite its known occurrence in estuaries. The three records for the cubera are from 23, 25, and 26 fathoms on Campeche Bank well offshore from estuarine conditions. This would seem to indicate that the cubera is a much less abundant species, rather than that vertical coverage was inadequate.

Table 1 - Depth Distribution of Eight Species of Western Atlantic Lutjanus. The Cubera, Dog, and Mahogany Are Not Included Because of Insufficient Records (See Text and Figure)

Species	Catch	Depth		
		Mean	Total Range	70% Range[1]
	No.	. . .	. . (Fathoms)	. . . . .
Mangrove	102	22	4-42	17-27
Lane	742	24	2-60	16-32
Schoolmaster	81	26	10-38	22-30
Mutton	253	27	4-47	22-32
Gulf red	1,223	29	5-80	17-41
Caribbean red	167	32	14-105	22-42
Blackfin	65	48	4-104	27-69
Silk	163	65	15-180	32-98

1/Where 68.26% of the records occur. Obtained from one standard deviation on each side of the mean and here rounded to 70% for convenience.

Seasonal coverage is also adequate except perhaps for July and December. The 2,809 stations that yielded Lutjanus are distributed (in percent of total) by month:

Jan.	Feb.	Mar.	Apr.	May	June
9%	9%	8%	13%	15%	5%
July	Aug.	Sept.	Oct.	Nov.	Dec.
2%	5%	11%	7%	12%	4%

The lower percentage in July, compared with April and May, results from decreased

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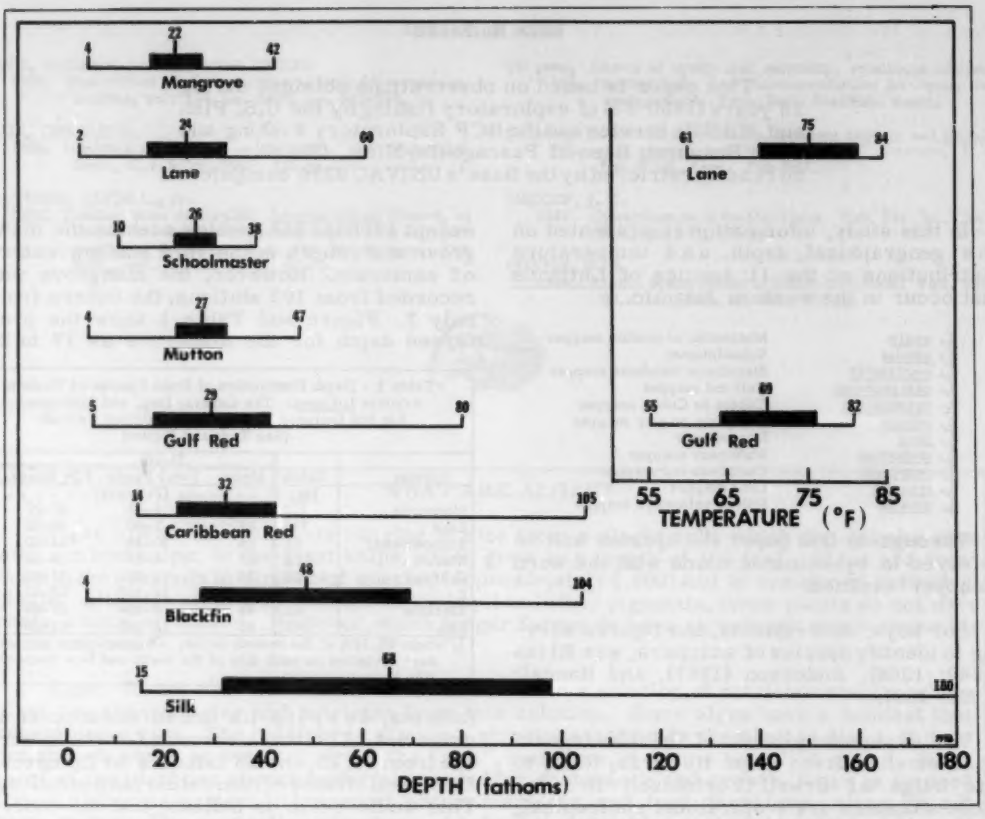

(Figure) Depth and temperature distributions of species of western Atlantic Lutjanus. Black bar indicates 68.26% of the records, obtained from one standard deviation on each side of the mean and rounded to 70% for convenience. Some species are not included because of insufficient records (see text and tables 1 and 2).

fishing effort; it is not to be interpreted as a change in seasonal abundance. When the monthly percentages on page 41 are combined by seasons, the coverage for spring is 33 percent, summer 18 percent, fall 23 percent, and winter 26 percent.

GEOGRAPHICAL DISTRIBUTION

The Gulf red and Caribbean red have separate geographic ranges, but the other species occupy about the same range, and the Gulf red and Caribbean red each occur with them.

Our data show the Gulf red is the species occurring farthest north. It was collected from Cape Hatteras southward and, apparently, is restricted to southeastern United States and the Gulf of Mexico. Mutton, mangrove, blackfin, lane, and silk do not occur north of Cape Fear, except perhaps as stragglers. The schoolmaster was not taken north of Jacksonville, Fla., and the Caribbean red apparently is confined to the Caribbean and southward to Brazil. Our data do not show any records north of the Honduran Banks for the Caribbean red, but records (Rivas, 1966) indicate that it occurs along Cuba's south coast. The data for cubera, dog, and mahogany are not sufficient to outline their distribution. All three records available for the cubera are from Campeche Bank. The five records for the dog are from off British Honduras and the coast of Colombia; however, it is known to occur as far north as south Florida and the Bahamas. There are only three records for mahogany--one from off Jupiter Inlet, Fla., another from Serrana

Bank in the central Caribbean, and a third from off French Guiana. In view of the extensive exploratory effort, it would seem that the few records for cubera, dog, and mahogany indicate less abundance rather than inadequate geographical coverage.

With the exception of the Gulf red, the other western Atlantic species of Lutjanus have been reported as occurring as far south as Brazil. Because our exploratory coverage in Brazil has so far extended only to off Fortaleza, the southern limits of distribution cannot be established from our records.

VERTICAL DISTRIBUTION

Vertical distribution of the eight most common western Atlantic species of Lutjanus is summarized in Table 1 and Figure. Because of insufficient records, cubera, dog, and mahogany are not included. The three records for cubera are from 23, 25, and 26 fathoms. Of the five records for the dog, two are from 5 fathoms, and three from 13 fathoms. The three records for mahogany are from 1, 14, and 16 fathoms.

The depth distribution of the lane, mutton, Gulf red, blackfin, and silk herein recorded agree with the findings of Camber (1955: 23) and Carpenter (1965: 8).

Table 1 and Figure show the depth range greater in the deeper occurring species, and that the blackfin and silk occur at significantly greater depths than the others. A study of catch composition shows that the mangrove, lane, schoolmaster, mutton, Gulf red, and Caribbean red--with mean depths of 22 to 32 fathoms--are often taken together; these are seldom taken with the blackfin and the silk, with mean depths of 48 and 65 fathoms, which are often taken together.

The relation of fish size to depth of occurrence indicates that in most, if not all, species, the juveniles and young occur shallower than the mean depth, and the larger adults deeper than the mean depth. For example, in the Gulf red, fish weighing less than $\frac{1}{4}$ to 2 pounds occur at 5 to 29 fathoms; 2- to 20-pound fish, at 30 to 34 fathoms; and 20- to 35-pound fish, at 35 to 80 fathoms. This relation agrees with findings by Caldwell (1955) for the longspined porgy, Stenotomus caprinus, and by Caldwell (1957) for the pinfish, Lagodon rhomboides.

TEMPERATURES OF OCCURRENCE

Despite few records of bottom temperatures, the data available suggest trends at least for some species. Here, only depth records with bottom temperature records are considered.

The seven records for the blackfin range from 64° to 77° F., with a mean of 71.1° F. at a mean depth of 64 fathoms; this is 16 fathoms deeper than the mean depth for the species (figure; table 1).

The eight records for the mangrove range from 65° to 81° F., with a mean of 70.8° F. at a mean depth of 18 fathoms; this is 4 fathoms shallower than the mean depth for the species (figure; table 1).

The 11 records for the mutton range from 66° to 82° F., with a mean of 76.6° F. at a mean depth of 27.5 fathoms--practically the mean depth for the species (figure; table 1).

The 15 records for the Caribbean red range from 64° to 84° F., with a mean of 78.4° F. corresponding to a mean depth of 35 fathoms; this is 3 fathoms deeper than the mean depth for this species (figure; table 1).

The 38 records for the silk range from 56° to 81° F., with a mean of 68.9° F. corresponding to a mean depth of 84 fathoms--19 fathoms deeper than the mean depth for this species (figure; table 1).

The 100 records for the lane (table 2) include all seasons and practically the species' entire geographical range. Bottom temperatures range from 61° to 84° F., with a mean of 75.2° F. at a mean depth of 23 fathoms; this is nearly the same as the mean depth for this species, 24 fathoms (figure; table 1).

The 268 records for the Gulf red (table 2) may be subdivided into three subregions that

Table 2 - Temperature Distribution of Two Species of Western Atlantic Lutjanus. The Other Nine Species Are Not Included Because of Insufficient Records (See Text and Figure)

Species	Catch[1]	Temperature		
		Mean	Total Range	70% Range[2]
	No.	F.	F.	F.
Lane	100	75°	61°-84°	68°-82°
Gulf red	268	69°	55°-82°	62°-76°

1/Catches for which bottom temperature records are available.
2/Where 68.26% of the records occur. Obtained from one standard deviation on each side of the mean and here rounded to 70% for convenience.

constitute the entire known geographical range of the species. The 53 records from Cape Hatteras to Cape Kennedy, Fla., range from 55° to 80° F.; the mean is 68.2° F., corresponding to a mean depth of 24 fathoms; this is 5 fathoms shallower than the mean depth of 29 fathoms for the species (figure; table 1). The 160 records for the northern Gulf of Mexico--from Cape Sable to the mouth of the Rio Grande--range from 59° to 80° F., with a mean of 67.5° F. corresponding to a mean depth of 31 fathoms; the mean is only 2 fathoms deeper than the mean depth for this species (figure; table 1). The 55 records from Cape Kennedy to Cape Sable, Fla., including the Florida Keys and the southern Gulf of Mexico to the mouth of the Rio Grande, range from 59° to 83° F. The mean is 71.7° F., corresponding to a mean depth of 27 fathoms, only 2 fathoms shallower than the mean depth for this species (table 1). As would be expected, the area from Cape Hatteras to Cape Kennedy and the northern Gulf of Mexico have about the same mean temperature--about 4° F. lower than that of the southern Gulf and south Florida. The similar and wide ranges of temperature variation in the three subregions indicate that the Gulf red is able to tolerate 55° to 82° F.

Bottom temperature records are absent or insufficient for schoolmaster, cubera, dog, and mahogany; as shown above, the records are weak for the remaining species, except the lane and Gulf red. Depth distribution within the same geographic range is similar, so temperature distribution for mangrove and schoolmaster may be inferred from the lane--and for mutton from that of the Gulf red, at least for the area in which both occur together.

The temperature variations discussed in this section may be attributed to season as well as depth.

HABITAT

Optimal bottom temperatures and depths are not necessarily indicative of snapper abundance unless they are associated with suitable bottoms. Camber (1955: 22) and Carpenter (1965: 8) reported that snappers prefer hard bottoms of broken relief covered with coral heads and outcrops of rocks. This bottom type is described and called "live-bottom habitat" by Struhsaker (1969: 272). According to Smiley (1885: 92), the Gulf red is almost certain to be found in the northern Gulf of Mexico where there is coral rock or gravel.

These comments apply to species of snapper that occur on the Continental Shelf to depths of about 100 fathoms, but mostly at depths below 70 fathoms. This would partly exclude the silk, which abounds also along the shelf edge or even on the upper Continental Slope. In this region, described and called "lower-shelf habitat" by Struhsaker (1969: 273), smooth mud bottom predominates. Apparently the silk may be found on this type of bottom, although it is not suitable for the other species.

LITERATURE CITED

ANDERSON, WILLIAM D., JR.
1967. Field guide to the snappers (Lutjanidae) of the western Atlantic. U.S. Fish Wildl. Serv., Circ. 252, iii + 14 pp.

CALDWELL, DAVID K.
1955. Distribution of the longspined porgy, Stenotomus caprinus. Bull. Mar. Sci. 5(3): 230-239.

1957. The biology and systematics of the pinfish, Lagodon rhomboides (Linnaeus). Bull. Fla. State Mus. 2(6): 77-173.

CAMBER, C. ISAAC
1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Fla. State Bd. Conserv. Tech. Ser. No. 12, 63 pp.

CARPENTER, JAMES S.
1965. A review of the Gulf of Mexico red snapper fishery. U.S. Fish Wildl. Serv., Circ. 208, iv + 35 pp.

RANDALL, JOHN E.
1968. Caribbean reef fishes. T.F.H. Publications, Inc., Jersey City, N.J., 318 pp.

JVAS, LUIS RENE
1949. A record of lutjanid fish (Lutjanus cyanopterus) for the Atlantic coast of the United States, with note on related species of the genus. Copeia 1949(2): 150-152.

1966. Review of the Lutjanus campechanus complex of red snappers. Quart. J. Fla. Acad. Sci. 29(2): 117-136.

SMILEY, CHAS. W. (Compiler)
1885. Notes upon fish and the fisheries. Bull. U.S. Fish Comm. 5: 65-112.

STRUHSAKER, PAUL
1969. Demersal fish resources: Composition, distribution, and commercial potential of the Continental Shelf stocks off southeastern United States. U.S. Fish Wildl. Serv., Fish. Ind. Res. 4(7): 261-300.

FISHERY OCEANOGRAPHY--VI
OCEAN FOOD OF SOCKEYE SALMON

Felix Favorite

A vital part of fishery oceanography is the knowledge of food chains and of the locations of high abundance of food organisms. Life stems from the sun; this is as true in the sea as it is on land. Microscopic single-cell plants, or phytoplankton, drifting in a thick soup of chemical nutrients (compared to the quantities available in most soils) use radiant energy from the sun to live and to multiply. In spring, a quart jar filled with water from the sea surface may contain a million of these cells--in some areas, many millions. Some cells, diatoms for instance, divide and produce two cells within the span of a day or less; if this process continued for a month, each cell would produce over a billion cells. One can easily visualize the significance of the so-called bloom of phytoplankton, which occurs each spring in high latitudes under the required environmental conditions of light, nutrients, and vertical stability in the water column. In the absence of large numbers of marine animals that graze on plankton, such blooms continue until one of the numerous nutrients required for plant growth is depleted.

Only a limited amount of research on nutrient chemistry has been accomplished in the Subarctic Pacific Region. However, if we consider the phosphate-phosphorus distribution (which has been studied) as indicative of nutrient concentrations (even though phosphate is recycled more rapidly than nitrate), it appears that nutrient concentrations are high and show no depletion in any season. Concentrations in the upper 100 meters of these waters are from 5 to over 10 the concentrations in waters farther south between 40° and 20° N., except off the west coast of North America where upwelling carries nutrients from deep water into the surface layer. The high concentrations in the Subarctic Region are also attributed to a vertical movement of deep water (explained in article IV of this series, November 1969 CFR). Some chemical studies indicate that nitrate may be limiting at times, but there is increasing evidence that the phytoplankton may be cropped by herbivorous zooplankton before the bloom reaches the immense proportions suggested by the high phosphate concentrations. Until more exhaustive chemical studies are made, we must accept this conclusion.

Measuring Plant Production Important

Nevertheless, there are methods of measuring the production of plant material over short periods of time, and estimates have been made of the animal life it is capable of supporting. These estimates are important in our control, or management, of the stocks of Pacific salmon (genus Oncorhynchus). Natural spawning areas in some river systems could be expanded and the capacity and number of salmon hatcheries increased to accommodate greater oceanic production. We believe that the hundreds of millions of salmon in the Subarctic Region constitute only a small fraction of the actual number of fish. We are unable, however, to determine how successful increased numbers of salmon would be in competing for food with the other organisms in this ecosystem. We know that the average weight of mature pink salmon (O. gorbuscha), which spend only 1 to 1½ years at sea, can vary 50 percent or more between years, and that it is not uncommon for mature pink and sockeye salmon (O. nerka) to be smaller in years when large numbers return to their natal river for spawning than in years when few return. Even though sockeye salmon usually spend the last 2 or 3 years of their lives growing and maturing in the ocean, their reduced size may be due to increased competition for food during the first year or two after hatching, which are spent in a fresh-water lake.

Experimental Fishing Catches More Salmon At Night

Pacific salmon grow and mature in the marine environment, but the effect of food

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distribution and abundance on their movements is not clear. In our experimental fishing, conducted with gill nets (approximately 3 m. in depth), it was obvious from the start that more salmon were caught at night than during the day. Almost without exception, when our fishing was conducted at night the majority of salmon were caught in the upper third of the nets. This was sometimes interpreted to signify that salmon rose to the surface at night to feed upon plankton or other organisms closely associated with plankton; others believed that salmon can see and avoid the gill net more readily during the day. But studies with sunken gill nets (as deep as 60 m.) have revealed sockeye and chum salmon (O. keta) during day or night at depths of at least 40 m. Chinook salmon (O. tshawytscha) are believed to be at much greater depths at times.

3 Major Species Eat Mostly Plankton

We know that three (sockeye, pink, and chum) of the five major species of Pacific salmon are predominately plankton feeders, but that they also consume small fish and squid. To ascertain their feeding habits, the stomach contents of over 5,000 sockeye salmon (caught in gillnets at 82 locations in the central Subarctic Region in 1960) were analyzed. Although another method of capture would have been preferable because salmon tend to regurgitate food when caught in a gill net, the results are interesting. The stomachs were divided into two categories--those collected in May and June, and those collected in July and August. Sockeye salmon caught in the Subarctic Region in May and June are mainly mature fish returning to river systems to spawn; those caught in July and August are mostly immature and will probably spend at least 1 more year in the ocean. Neither group had difficulty finding food over a wide area of the ocean (fig. 1). At 68 of the stations, over 50 percent of the stomachs were at least $\frac{1}{4}$ full. This suggests that salmon obtain food in areas other than the immediate Aleutian Island area, which has been considered the primary "feeding ground" for salmon. The average percentages of the total stomach contents contributed by different taxonomic groups were: amphipods - 43, fish - 18, squid - 16, euphausiids - 12, copepods - 7, pteropods - 2, and unidentified - 2. Other investigators found for other years that copepods or euphausiids were the dominant organisms in stomachs of sockeye salmon, but it is not known whether these organisms were predominant in the plankton during those years.

No particular organism dominated in the stomachs of fish taken at individual locations (fig. 2), nor was there any particular distribution pattern. This was not surprising because all stations were within the subarctic regime. The distribution of species within taxonomic groups probably differed among stations or groups of stations. But such differences are difficult to demonstrate because identifying characteristics are usually obliterated by ingestion and digestion.

Estimating Food Abundance Near Fishing Stations

Because of the great variety of food eaten by sockeye salmon, an estimate of the abundance of all food organisms in the vicinity of a fishing station would require the towing of numerous sampling devices (with various mesh sizes). These would have to be at various speeds and depths, throughout the water column, and over a large area. Such studies have not been possible. Although we have made vertical plankton hauls with small-mesh nets, the samples were inadequate to estimate the food organisms available to salmon. Once, during the early phases of our work, a two-ship operation took place in which a fishing vessel set a gillnet and an oceanographic research vessel made exhaustive plankton hauls throughout the night at various distances from the net. Unfortunately, no salmon were caught, and we have not had an opportunity to repeat this kind of experiment. Such studies of the relation between food available and food eaten would also require knowledge (still largely lacking) of the rate at which salmon digest food organisms. This merely points out, again, the frustrations and difficulties encountered in fishery oceanography.

Nevertheless, in spring and summer 1961, we made 24-hour investigations of the vertical distribution of macro-plankton at numerous locations. A modified Isaacs-Kidd trawl was towed at 25-m. depth intervals from the surface to 200 m. At three representative stations, the maximum biomasses were at 50, 125, and 125 m. during the day, and 25, 25, and 100 m. at night (fig. 3). The effects of these distributions of food organisms upon the vertical distributions of salmon are still unresolved. The analysis of the contents of a limited number of stomachs from sockeye salmon caught during late winter in 1962 indicated active feeding on amphipods and lanternfishes. It was previously believed that little, if any, food is consumed during this period because

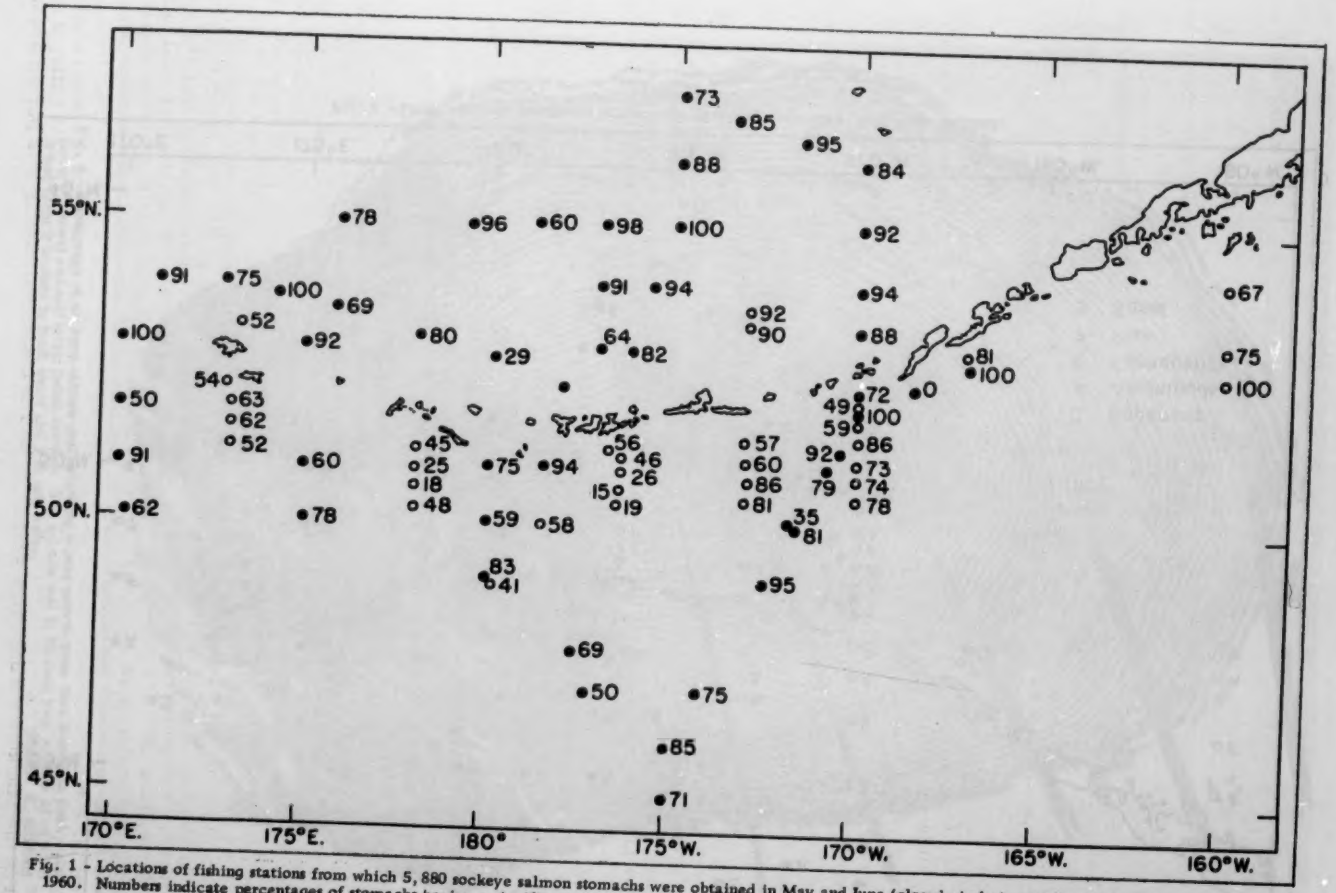

Fig. 1 - Locations of fishing stations from which 5,880 sockeye salmon stomachs were obtained in May and June (closed circles) and July and August (open circles), 1960. Numbers indicate percentages of stomachs having a significant food content.

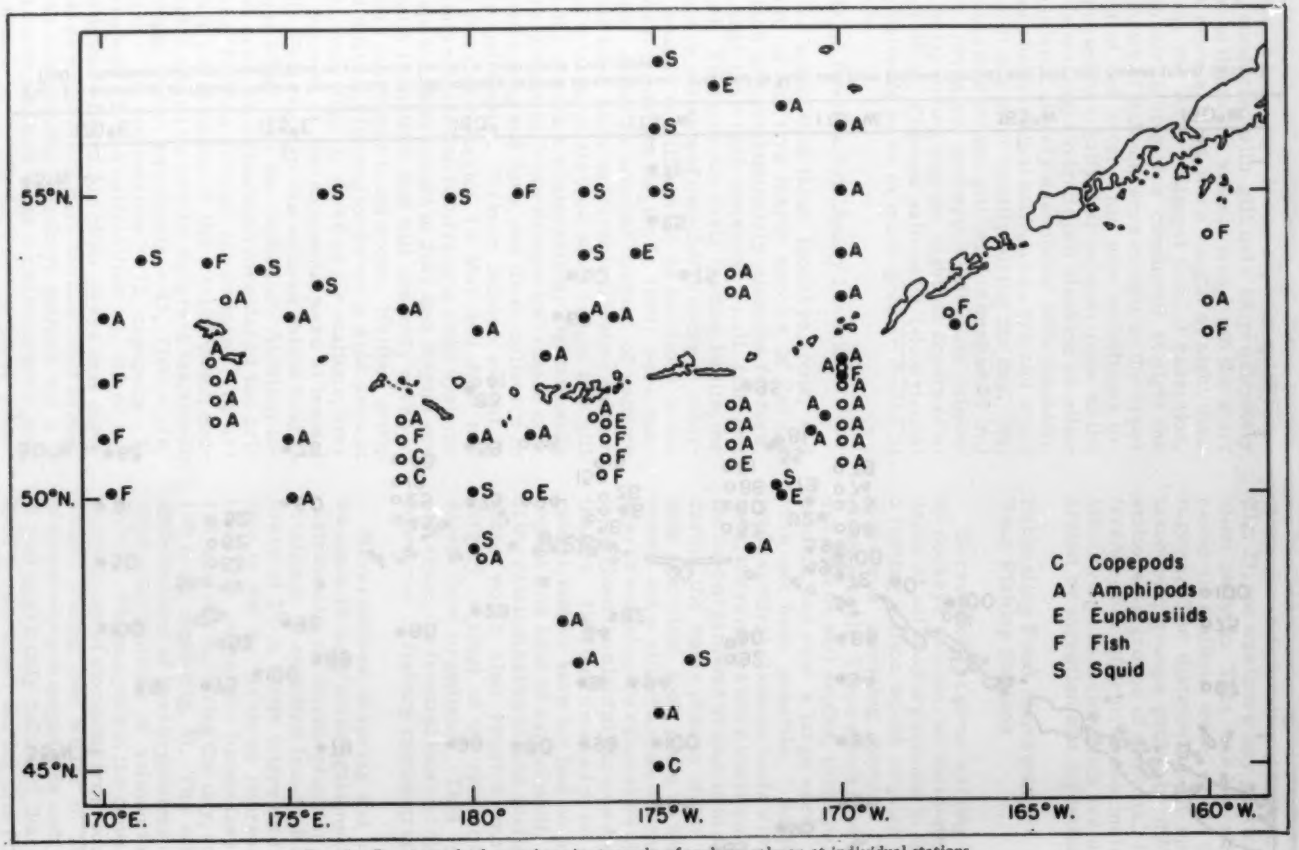

Fig. 2 - Dominant food organisms in stomachs of sockeye salmon at individual stations.

Fig. 4 - Photograph of sockeye salmon scale showing winter growth zones that formed in fresh water (narrow arrows) and salt water (wide arrows). The salmon was in its sixth year at time of capture: it had spent 2 winters in fresh water and 3 in salt water. (Photo: K. Mosher)

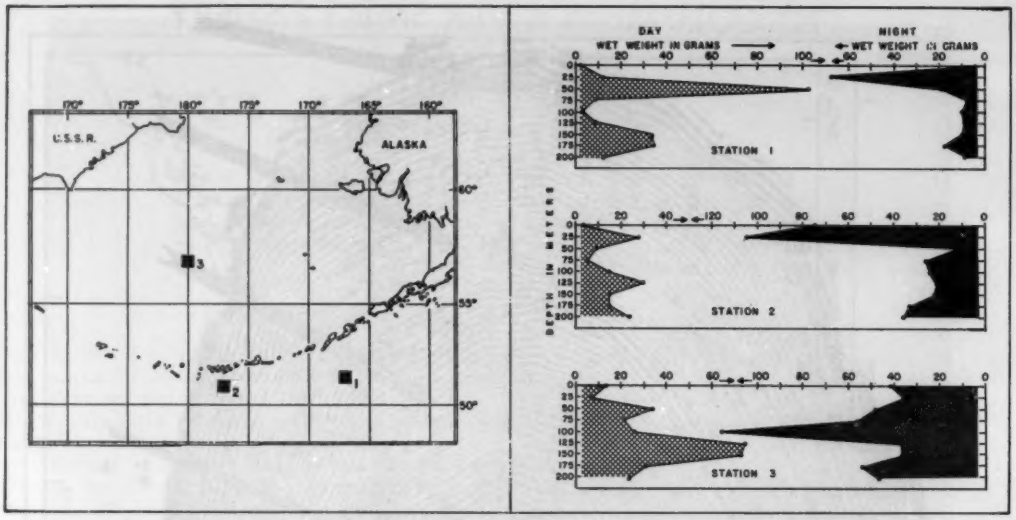

Fig. 3 - Vertical distribution of biomass at 25-m. depth intervals at three stations, during the day and at night, as determined by catches in a 3-foot Isaacs-Kidd midwater trawl.

the narrow spacing of circuli on the scales suggests little growth. The narrow spacing during winter is significant. It permits us to ascertain the age of the salmon by counting year-marks, which are analogous to the rings in a cross-section of a tree trunk (fig. 4).

Study Biomasses of Environmental Waters

We are completing biological studies along a line of stations south of Adak Island to ascertain if the various environmental waters, such as the Alaskan Stream and the Subarctic Current, and the Ridge Area which separates these two systems, have characteristic biomasses. It appears that the phytoplankton bloom is greatest inshore in early spring--but that the standing stock of zooplankton is greatest in the Ridge Area. This has been interpreted to mean that grazing by large numbers of zooplankton in offshore areas prevents the standing stock of phytoplankton (as indicated by the nutrients) to attain its immense potential. Extensive grazing in turn seriously restricts the potential plankton production in the Subarctic Region.

Further estimates of potential primary production are being made on the basis of cloud cover data obtained from ESSA satellite photographs. Monthly averages of daily cloud cover indicate that previous estimates based upon sporadic ship reports are not representative; thus values of incident radiation, corrected for shielding by clouds, are in error. Production of phytoplankton is directly related to incident radiation. Even though zooplankton cropping may exist, knowledge of areas of minimum cloud cover in spring could possibly denote areas of high primary production and, therefore, possible feeding areas for adult salmon before or during their spawning migration to natal streams in late spring.

Thus we are entering a predictive phase. This, of course, is the ultimate goal of all oceanography programs--to obtain enough knowledge of the conditions and processes in a particular system to make long- and short-range predictions. Some scientists feel that we are at least 10 years, and perhaps many decades, away from such a goal. This period of time may be a gross underestimate or overestimate, depending upon the requirements and use of the prediction. Yet each step should pave the way to ultimate success. In the next article, the last in this series, I will describe our attempts to forecast ocean current flow in the salmon environment.

OTTER TRAWLING INTRODUCED TO COLUMBIA RIVER SMELT FISHERY

A Progress Report

Ian E. Ellis and Clint Stockley

An otter trawl net was test fished in the Columbia River to catch eulachon. Limited commercial trawling caught about three times as many eulachons per day as gill netting did during the same period. Trawl gear costs less than gill nets and produces higher quality fish with less effort.

The fishery on the eulachon or Columbia River smelt, Thaleichthys pacificus, has used gill nets for many years (Pruter, 1966). The excessive handling and associated time loss using this method, plus high wastage and the product's frequently poor appearance, inspired a search for a better harvesting method. Initial results of a joint study by the Columbia River Laboratory of the Washington State Department of Fisheries and BCF's Exploratory Fishing and Gear Research Base at Seattle, Washington, indicate the potential value of using small trawl nets in the eulachon fishery (figure 1).

THE FISHERY

Eulachon enter the Columbia River in November and are subjected to the commercial gill net fishery until they enter the tributaries, where they are taken by dip nets. While in the main river, the fish move up and down the river as well as vertically through the water column (Snyder, 1969). Eulachon form dense schools near the bottom on the ebb tide and are taken by weighted "diver" (sunken) nets. At the turn of the tide, and on the flood tide, the fish are at intermediate depths where they are caught by "bobber nets" (gill nets

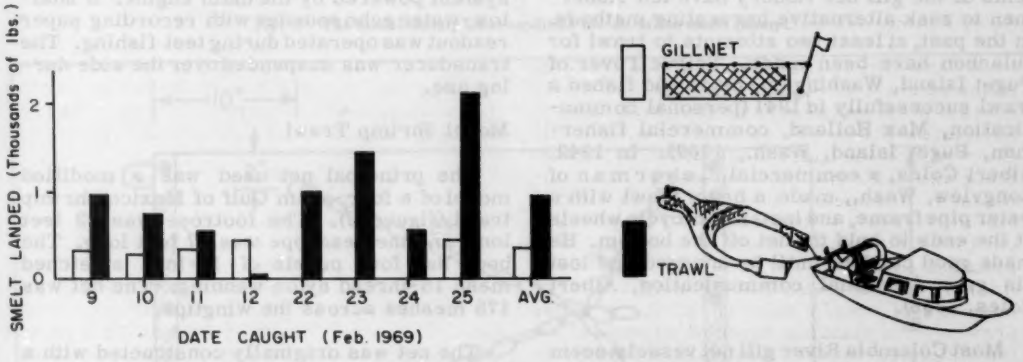

Fig. 1 - A comparison of daily catch of eulachon by an otter trawl (table 3) with the daily average catch of a sample of gill net fishermen (table 4).

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suspended below the surface by dropper lines). At high slack water, the fish are scattered near the surface and are taken with surface-floating gill nets.

Gill netting, normally a one-man operation, involves considerable handling, duplication of gear, and travel time. It is customary to fish two or more gill nets. Each net is fished by repeatedly drifting through the fishing area until the net is loaded. When all nets are loaded, the fisherman runs the boat to his shaking raft or dock. Then he removes each net from the boat, pulls it free in sections, and shakes each section vigorously to remove the smelt. When the smelt are clear of the net, he shovels them into boxes.

This process produces a poor-quality product. A net may be set and retrieved two or three times before the fish are removed (recapping); this causes some of the catch to be dragged over the boat rail several times. The fish are carried on the vessel tangled in the net with bodies distorted for some time before removal. Many fish have their heads snapped off during the shaking process, and the catch may include dirt and slivers off the floor of the shaking area when shoveled into boxes. In many cases hand sorting is required to remove badly damaged fish. These problems of the gill net fishery have led fishermen to seek alternative harvesting methods. In the past, at least two attempts to trawl for eulachon have been made. Trigve Tover of Puget Island, Washington, made and fished a trawl successfully in 1941 (personal communication, Max Holland, commercial fisherman, Puget Island, Wash., 1969). In 1942, Albert Coles, a commercial fisherman of Longview, Wash., made a beam trawl with a water pipe frame, and installed bicycle wheels at the ends to hold the net off the bottom. He made good catches until he snagged and lost his gear (personal communication, Albert Coles, 1968).

Most Columbia River gill net vessels seem suitable for handling small trawls. Several have gasoline engines in the 200- to 400-horsepower range, whereas trawls have been towed by vessels with engines as small as 25 horsepower (Baldwin, 1961). Also, some of the vessels have power-drive gill-net reels that could facilitate handling of the gear.

Washington State fishery regulations do not permit trawling in the Columbia River; however, the Department of Fisheries can issue permits for trawling provided permittees obtain trawl licenses. Because the 1969 effort was experimental, the State issued a special test-fishing permit, at no cost, which allowed experimental trawling while a Department representative was aboard. All catches had to be returned to the water. The success of the initial attempts led the fishermen to purchase a trawling license and to obtain a special permit to use trawl gear on a commercial basis.

METHODS AND MATERIALS

Several sources contributed to the program. The Washington Department of Fisheries provided background knowledge, a special fishing permit, and program monitoring. The BCF Exploratory Fishing and Gear Research Base furnished the trawling gear and technical advice on using it. Captain Arthur Peterson provided his and his mate's services and his vessel for the trawling trials in the main stem of the Columbia River near Longview, Washington.

Vessel

The vessel used was the stern fishing, gillnet 'Sandy,' 32 feet long and with a 325-horsepower gasoline engine. The net was hauled on a gill net reel, which has a hydraulic drive system powered by the main engine. A shallow-water echo sounder with recording paper readout was operated during test fishing. The transducer was suspended over the side during use.

Model Shrimp Trawl

The principal net used was a modified model of a four-seam Gulf of Mexico shrimp trawl (figure 2). The footrope was 22 feet long, and the headrope was 17 feet long. The body had four panels of $1\frac{1}{4}$-inch stretched mesh 15-thread nylon webbing. The net was 175 meshes across the wingtips.

The net was originally constructed with a horizontal separator panel and upper and lower cod ends, similar to the French "trouser trawl" (Boddeke, 1965) to test the French shrimp-sorting techniques in Pacific Northwest waters. The separator panel was removed from the net and a body liner of $\frac{5}{8}$-inch stretched mesh webbing was constructed and installed in the trawl. The liner was hung to the meshes along an imaginary line 50 meshes behind the center of the headrope and 20 meshes behind the center of the footrope. The

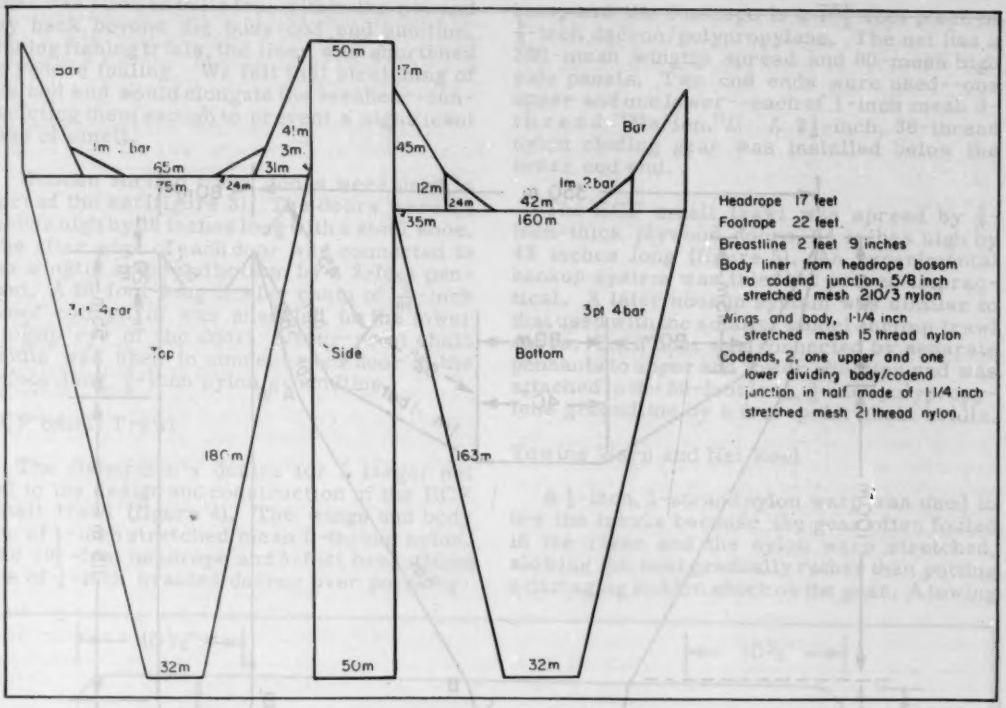


Fig. 2 - The model shrimp trawl modified for use in the smelt fishery.

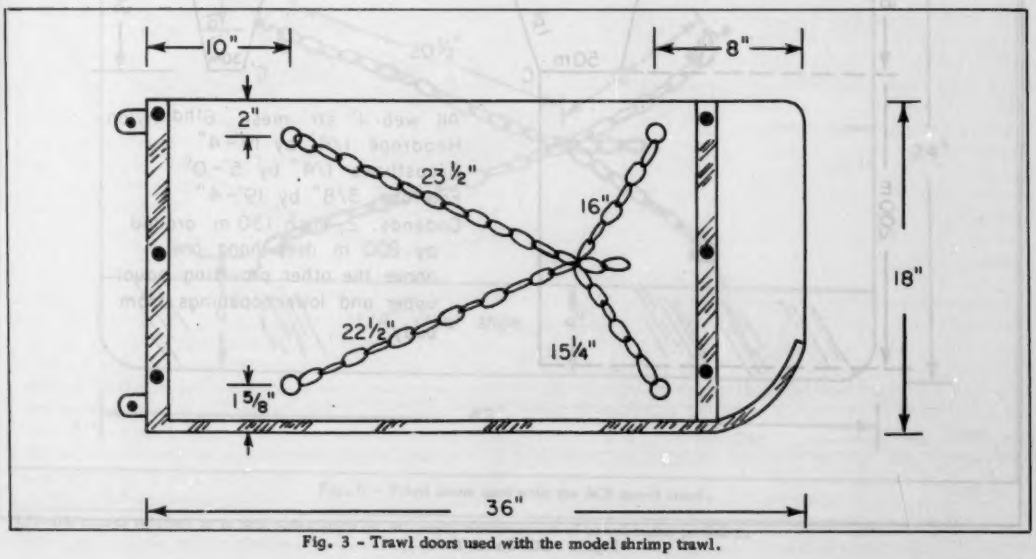


Fig. 3 - Trawl doors used with the model shrimp trawl.

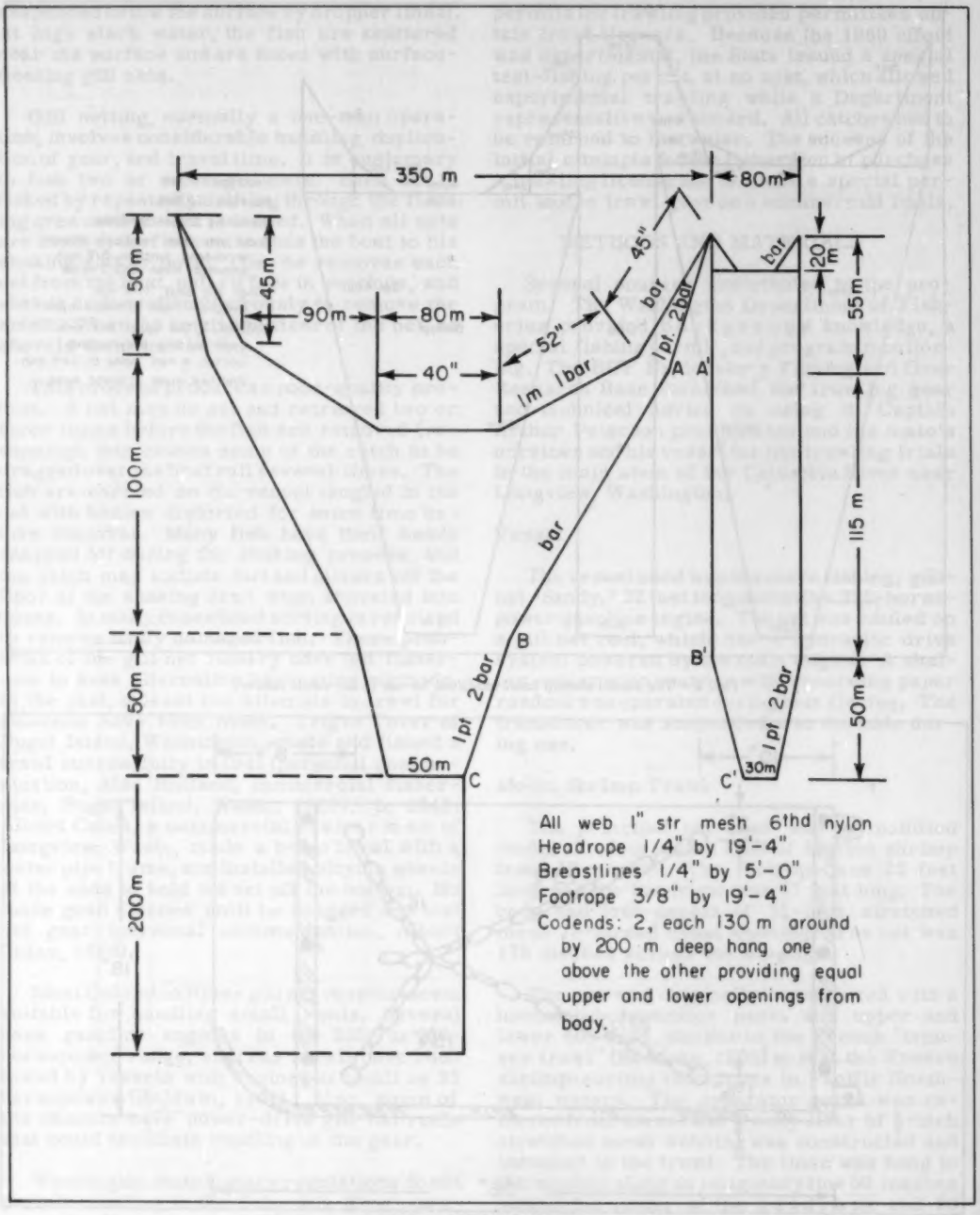


Fig. 4 - BCF Smelt Trawl

liner was allowed to lie free within the net and lay back beyond the body-cod end junction. During fishing trials, the liner was shortened to reduce fouling. We felt that stretching of the cod end would elongate the meshes--constricting them enough to prevent a significant loss of smelt.

Wooden shrimp trawl doors were used to spread the net (figure 3). The doors were 18 inches high by 36 inches long with a steel shoe. The after edge of each door was connected to the wingtip at top and bottom by a 3-foot pennant. A 26-foot-long tickler chain of $\frac{5}{64}$-inch proof coil chain was shackled to the lower wingtip eye of the door. A four-point chain bridle was used to connect each door to the 3-foot-long, $\frac{3}{8}$-inch nylon groundline.

BCF Smelt Trawl

The fishermen's desire for a larger net led to the design and construction of the BCF smelt trawl (figure 4). The wings and body are of $\frac{1}{2}$-inch stretched mesh 6-thread nylon. The $19\frac{1}{2}$-foot headrope and 5-foot breastlines are of $\frac{1}{4}$-inch braided dacron over polyethylene, and the footrope is a $19\frac{1}{3}$-foot piece of $\frac{3}{8}$-inch dacron/polypropylene. The net has a 350-mesh wingtip spread and 80-mesh high side panels. Two cod ends were used--one upper and one lower--each of 1-inch mesh 9-thread "Marlon."1/ A $2\frac{1}{2}$-inch, 36-thread nylon chafing gear was installed below the lower cod end.

The BCF smelt trawl was spread by $\frac{3}{4}$-inch-thick plywood doors, 24 inches high by 42 inches long (figure 5). An experimental hookup system was tried but proved impractical. A later hookup system was similar to that used with the smaller model shrimp trawl doors. Each door was connected by separate pennants to upper and lower wingtips and was attached to the 50-foot long, $\frac{3}{8}$-inch polypropylene groundline by a four-point chain bridle.

Towing Warp and Net Reel

A $\frac{1}{2}$-inch, 3-strand nylon warp was used to tow the trawls because the gear often fouled in the river and the nylon warp stretched, slowing the boat gradually rather than putting a damaging sudden shock on the gear. A towing

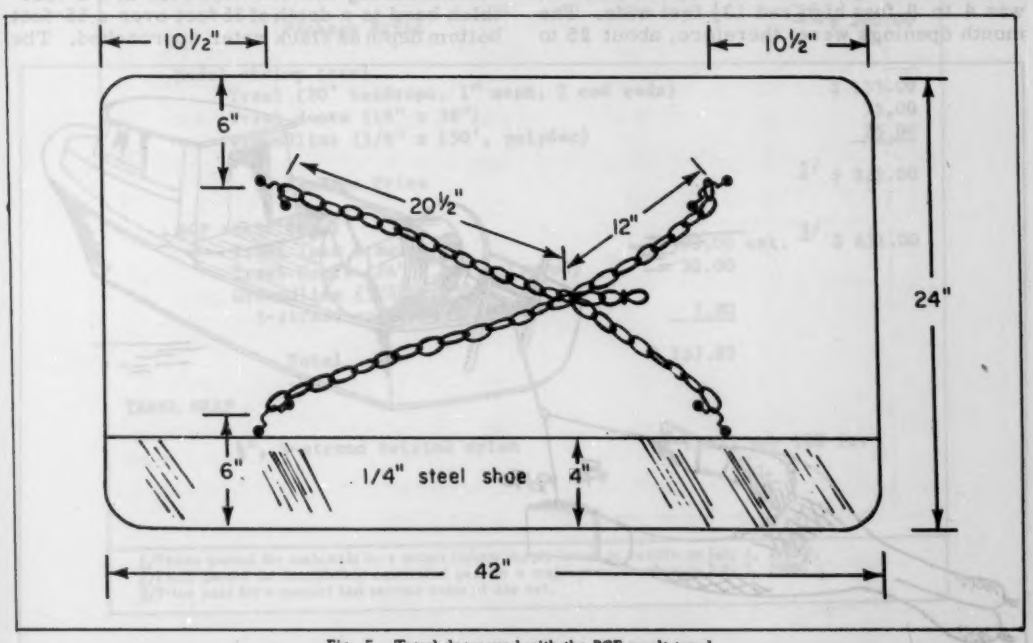


Fig. 5 - Trawl doors used with the BCF smelt trawl.

1/Trade names referred to in this publication do not imply endorsement of commercial products.

eye was tied into the warp at each anticipated towing point, and a towing bridle, anchored to hull cleats, was used to take the strain off the reel while towing. The nylon warp and groundlines were wound on the gill net reel (figure 6). The depth of the net was altered by paying out or taking up line on the powered reel; this eliminated much physical labor. The reel had sufficient power to haul easily and unaided one catch of 600 pounds over the rail and into the vessel.

Gear Costs

Table 1 compared costs of the major components of trawl system and gill nets.

Diver Observations

The trawl gear was observed by divers in Puget Sound. The model shrimp net with 18-inch by 36-inch doors rigged as in the commercial tests was found to be $3\frac{1}{2}$ to 4 feet high at the center of the headrope and 8 feet wide. The BCF smelt trawl with 18-inch by 36-inch doors was 4 to 8 feet high and $12\frac{1}{2}$ feet wide. With 24-inch by 42-inch doors, the BCF net was 4 to 8 feet high and $13\frac{1}{2}$ feet wide. The mouth openings were, therefore, about 25 to 30 square feet for the shrimp trawl, 35 to 75 square feet for the smelt trawl with small doors, and 40 to 85 square feet for the smelt trawl with large doors.

These nets were set and retrieved by hand without difficulty from BCF's 23-foot vessel 'Sea Probe.'

Test Fishing

The model shrimp trawl was tested in the Columbia River on February 6 and 7 under the conditions of a permit from the Washington Department of Fisheries to conduct experimental fishing. Four bottom tows were made each day during the ebb tide. Catches varied up to 350 pounds in a 14-minute tow (table 2). These catch rates were sufficiently encouraging so that the fishermen purchased a trawling license to fish commercially.

Useful information was obtained from these tests. The Washington Department of Fisheries observer, using a portable recording echo sounder, saw apparent fish signs on bottom during the ebb tide rise in a 2-foot-thick band to a depth of 35 feet over a 55-foot bottom depth as slack water approached. The

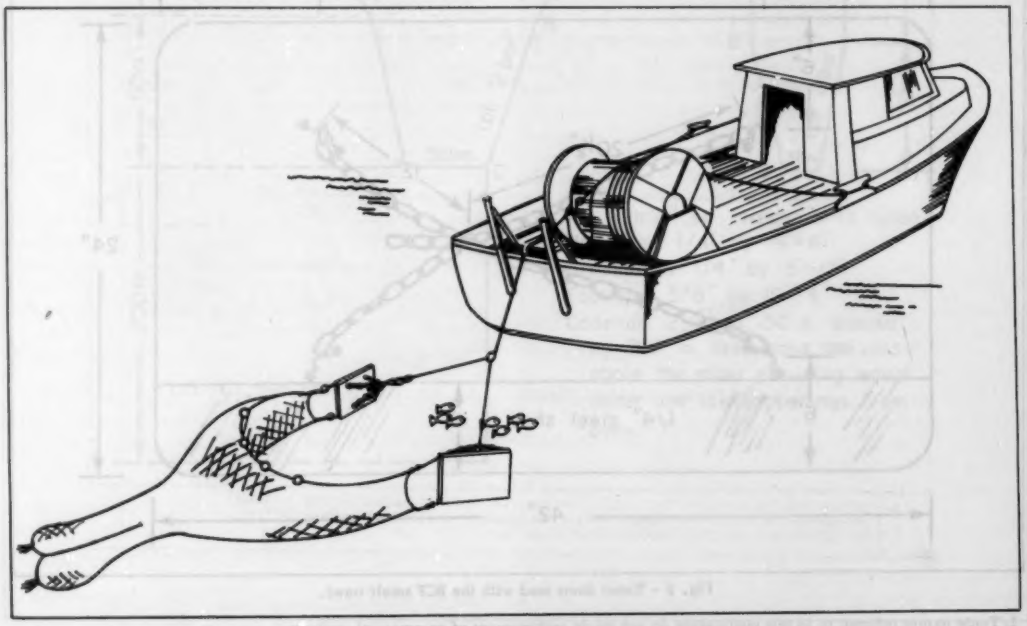


Fig. 6 - Stern picking gill net vessel with reel as rigged for smelt trawling.

Table 1 - Smelt Gear Costs

	Materials Only	Complete
GILL NETS		
Diver gill net 90 fms. long x 60 meshes deep	1/ $ 251.80	
Floater gill net 100 fms. long x 100 meshes deep	1/ 315.10	
Bobber gill net 130 fms. long x 125 meshes deep	1/ 479.29	
TRAWLS		
Model shrimp trawl		
Trawl (20' headrope, 1¼" mesh, 2 cod ends)		$ 110.00
Trawl doors (18" x 36")		75.00
Groundline (3/8" x 150', polydac)		25.00
Package Price		2/ $ 200.00
Model shrimp trawl		
Trawl (20' headrope, 1" mesh, 2 cod ends)		$ 135.00
Trawl doors (18" x 36")		75.00
Groundline (3/8" x 150', polydac)		25.00
Package Price		2/ $ 225.00
BCF smelt trawl		
Trawl (per drawing)	$ 100.00 est.	3/ $ 431.00
Trawl doors (24" x 42", plywood)	50.00	
Groundline (3/8" x 150', 3-strand polypropylene)	7.80	
Total	$ 157.80	
TRAWL WARP		
½", 3-strand twisted nylon	$ 13.25 per 100 ft.	

1/Prices quoted for materials by a major fishery supply house in Seattle on July 1, 1969.
2/Price quoted for completely assembled gear by a major manufacturer on July 1, 1969.
3/Price paid for a special fast service order of one net.

Table 2 - Tows Made With Model Shrimp Trawl During Fishing Tests

Date	Elapsed Time	Water Depth	Warp Length	Smelt Caught
	Minutes	Feet	Feet	Pounds
February 6	15	20-25	150	3/4
" 6	15	20-54	250	76
" 6	32	50-80	350	50
" 6	33	30-55	540	22
February 7	19	50-80	300	10
" 7	14	50-80	300	98
" 7	18	50-80	350	3
" 7	14	50-65	350	350

1/Log in net.
2/Log in the net tore the webbing.

Table 3 - Trawl Caught Smelt Landings by the Vessel Sandy

Date 1969	Drags Made No.	Mean Drag Time Minutes	Total Drag Time Minutes	Eulachon Catch Pounds	Catch per Effort Lbs./Min.
2/9	5	20	100	975	9.8
2/10	6	20	120	750	6.2
2/11	6	22	132	550	4.2
2/12 1/	1	19	19	67	3.5
2/22	5	12	60	1,000	16.7
2/23	5	30	150	1,450	9.7
2/24	3	30	90	550	6.1
2/25 2/	5	30	150	2,100	14.0

Total eulachon landed (pounds) - - - - -	7,442
Days fished (number)- - - - - - - - - - -	8
Average catch per day (pounds)- - - - -	930.3
Average catch per drag (pounds) - - - - -	212.7

1/Smelt run entered Cowlitz River--trawl fishermen made one tow then switched to dip netting from 2/15 to 2/20.
2/Large run entered Cowlitz River--trawl fishermen switched to dip netting.

upper and lower cod ends were also found useful. The eulachon mainly entered the upper bag while gravel and heavy trash went into the bottom bag.

The BCF smelt trawl was completed after the end of the gill net season. On March 6, near Mayger, Oregon, an 8-minute tow with the trawl spread by 24-inch by 42-inch doors yielded 61 pounds of eulachon. On March 21, near Puget Island, Washington, a 20-minute tow with the trawl opened by 18-inch by 36-inch doors yielded 25 pounds, and an 18-minute tow caught 15 pounds.

Commercial Fishing

Commercial trawling with the model shrimp net was conducted during two periods--February 8 to 12 and February 21 to 25. The trawl fishermen shifted to dip netting for eulachon in the Cowlitz River from February 15 through 20. A total of 35 commercial drags were made. Daily landings by the commercial trawling vessel ranged from 67 pounds on February 12 to 2,100 pounds on February 25 (table 3). The average landing per day was 930 pounds or 465 pounds per man-day. These numbers do not include about 200 pounds of fish given to the BCF Biological Station at Prescott, Oregon, for studies.

No commercial trawling was done after February 25 because the trawl fishermen were engaged in the Cowlitz River dip net fishery, which finally glutted the market.

Representative landings by the gill net fishery during this period are presented in table 4 for comparison. Each landing represents one fisherman's catch for 1 day. The average landings, 339 pounds of eulachon per man-day, is about two-thirds the daily average trawl caught landing per man during this period.

CONCLUSIONS

Trawling for smelt in the Columbia River indicated that this method may be superior to the present method of gill netting. Trawl gear is less expensive, more durable, and may be used at different tidal stages. There is less time loss with trawl gear because net shaking

Table 4 - Representative Landings of Columbia River Smelt Taken by Commercial Gill Net Fishermen
(Each Figure Is One Fisherman's Catch in Pounds for 1 Day)

Date	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Daily Average
2/9	457	407	364	400	-	400	400	53	250	84	313
2/10	250	400	368	250	250	25	250	250	250	350	264
2/11	425	250	617	600	300	250	250	250	300	145	339
2/12	275	460	550	-	-	575	450	300	-	-	435
2/13 1/											
2/25	250	250	625	625	-	-	-	-	-	-	438
2/26 1/											

Total eulachon landed (pounds) - - - - -	13,205
Vessel-days fishes (number)	39
Average landing (pounds)	338.6

1/Smelt run entered Cowlitz River--gill net fishermen switched to dip netting.

is not required. The product is in much better condition. The method can be used with little or no modification to many existing vessels.

SUMMARY

Otter trawls were used to take smelt in the Columbia River. Two days of test fishing encouraged fishermen to engage in a commercial trawl fishery during the period open to the gill net fishery. The trawlers landed nearly three times as many fish per day as the average of a sample of gill netters. The trawl-caught fish were in excellent condition. Some held in an aquarium suffered no mortality from the time of capture through the first 2 days.

ACKNOWLEDGEMENTS

We thank sincerely Albert Coles of Longview, Wash., whose suggestions and comments led to this program. Captain Arthur Peterson and his mate, Max Holland, of the 'Sandy' volunteered and made the field tests. Dennis Austin, Washington Department of Fisheries, monitored the test fishery. Jerry Jurkovich, BCF gear specialist, suggested changes that were incorporated in both trawl systems.

REFERENCES

BALDWIN, WAYNE J.
1961. Construction and operation of a small boat trawling apparatus. Calif. Fish Game 47(1): 87-95.

BODDEKE, R.
1965. En beter garnalennet (a new selective shrimp trawl). Visserij-Nieuws 18(1): 2-8.

PRUTER, A. T.
1966. Commercial fisheries of the Columbia River and adjacent ocean waters. U.S. Fish Wildl. Serv., Fish. Ind. Res. 3(3): 17-68.

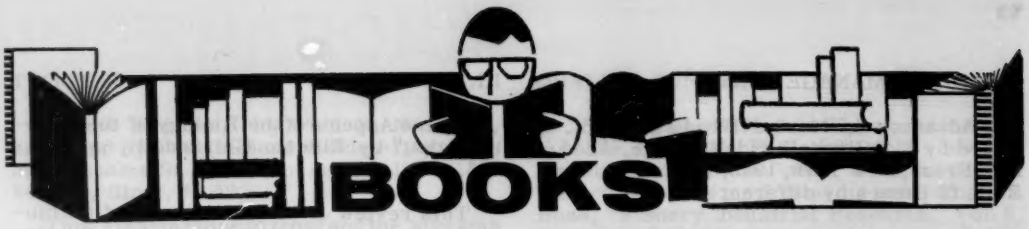
SNYDER
1969. Thermal pollution and the Columbia River Smelt. The Oregon Sportsman 2(8): 5-6.

WHO HIRES OCEANOGRAPHERS?

Between 2,500 and 3,000 scientists and technicians are employed in oceanography and related fields of marine science in the United States, and the number is growing. Most of these scientists are employed by colleges and universities and by university-operated oceanographic laboratories, where they are usually engaged primarily in research.

The Federal Government employs a substantial number of oceanographers. Many oceanographic positions are in activities of the Navy; the Naval Oceanographic Office in the Washington, D.C., area probably employs more than any other single activity. Government agencies with sizable oceanographic staffs are ESSA (Environmental Science Services Administration), with laboratories located in Miami and Seattle; BCF (Bureau of Commercial Fisheries) with laboratories at 14 coastal locations; and Public Health Service, with three shoreside research stations. The Bureau of Mines marine work is at Tiburon Island, California. Marine scientists employed by the U.S. Coast Guard and the CERC (Army Engineers) are usually based in Washington, D.C. A total of 22 Government agencies conduct oceanographic work of some kind. States bordering the ocean and Gulf of Mexico also employ quite a number of marine specialists.

Oceanographers are employed in limited but growing numbers by private industry (manufacturers and consulting firms), independent nonprofit laboratories, fishery laboratories, and local Governments. ("Questions About The Oceans," U.S. Naval Oceanographic Office.)



CATFISH FARMING

"A Synopsis of Catfish Farming," by E. Evan Brown, M. G. LaPlante and L. H. Covey, Bulletin 69, College of Agriculture Experiment Stations, University of Georgia, Athens, Georgia, September 1969, 50 pp., illus.

This is a report on contemporary channel catfish research and farming. Particular attention is paid to: 1) spawning and hatching, 2) chemical control of diseases and parasites, 3) pond construction and water quality control, 4) feeding, 5) harvesting, 6) marketing, and 7) expected costs and returns.

CUISINE

"Seafood Moods," sold by Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402, $0.60.

A new recipe booklet, illustrated in color, featuring seafoods from the states of Washington, Oregon, and Alaska. For years, many of the marine delicacies from these states were available only locally. Now, advanced processing techniques, packaging methods, and transportation make it possible for housewives all over the nation to prepare the traditional culinary favorites of the Northwest.

DESALTING

"Desalination," by Roy Popkin, Praeger, New York, 1968, 235 pp.

Sea and brackish water can be made safe for drinking, farming, and industry by desalting. Mr. Popkin reviews the latest methods of desalination, its future direction, and its costs and values in different circumstances. He also suggests ways to evaluate desalting's role in solving local, national, or regional water problems.

GREAT LAKES LEGAL PROBLEMS

"The Land-Sea Interface of the Great Lakes States of the United States: Legal Problems Arising out of Multiple Use and Conflicts of Private and Public Rights and Interests," sold by Clearinghouse for Federal Scientific and Technical Information, 5285 Port Royal Rd., Springfield, Va. 22151, as P.B. No. 186,000 (3 reels of 16 mm. microfilm), $27.

A compilation of all the laws and their impact on activities related to the Great Lakes. Hundreds of legal cases, claims, and questions arising from use and exploitation of the lakes, their contiguous waterways, and land areas are listed and summarized. Grouped systematically, they cover such diverse activities as fishing, boating, shoreline construction, dredging, flood control, pollution, etc.

The report is a remarkable repository for the jurist, lawyer, conservationist, developer, and others interested in developing an effective legal machinery to evaluate competing claims and interests.

PACIFIC COAST

"Between Pacific Tides," by E. F. Ricketts and Jack Calvin (4th edition), revised by Joel W. Hedgpeth, Stanford University Press, 1968, 614 pp., illus.

There are few guides to seashore animals based on original observation. This is one of them. First published in 1939, it is still in demand. Perhaps this is because no one else has presented the information in such a readable manner. Although meant for the student or amateur observer, who is limited to the shore, it is equally interesting to the armchair explorer. Dr. Hedgpeth's contributions, both scholarly and pungent, add much to the reader's enjoyment. An annotated systematic index and a general bibliography form valuable parts of the book.

RESOURCE MANAGEMENT

"Advances in Marine Biology," vol. 6, edited by F. S. Russell and M. Yonge, Academic Press, New York, 1968, 406 pp., indexed, illus. (3 papers by different authors).

I. Resource Management

"Management of Fishery Resources," by J. A. Gulland, pp. 1-71.

World catches are increasing due to the expansion of local fisheries and the rapidly growing numbers of factory and other vessels operating far from their home bases. These trends have intensified the problems of overfishing, and developed an urgent need for the regulation and management of the resources.

Historically, the fishing industry's classic response to overfishing in one stock has been to move to other, usually more distant, stocks. But this process cannot continue much longer. At the present rate, few substantial unexploited stocks of fish accessible to the present types of gear will remain in another 20 years. The problem is not confined to the high seas; it occurs also in inland waters, where biological problems are essentially the same.

Mr. Gulland urges immediate attention to the problems of proper fishery-resource management. Without some fundamentally new approach, he doubts that the production of world fisheries can keep up with the increase in world population.

The paper covers: depletion of marine resources; methods of regulation and limitation; mechanics of management and international law; territorial seas and specialized fishery bodies, and problems and prospects of future progress.

II. Fish Culture

"A General Account of the Fauna and Flora of Mangrove Swamps and Forests in the Indo-West-Pacific Region," by William Macnae, pp. 73-270.

Contains some interesting information on pond culture of fish and prawns in mangrove swamps.

III. Arrow worms

"Some Aspects of the Biology of the Chaetognaths," by Elvezio Ghirardelli, pp. 271-375.

This review of certain aspects of the biology of chaetognaths pays particular attention to the biology of reproduction, and to some organs and functions not previously studied.

SHELLFISH SANITATION

"Proceedings, Sixth National Shellfish Sanitation Workshop," edited by George Morrison, Department of Health, Education, and Welfare, 115 pp. Copies may be obtained from Shellfish Sanitation Branch (RC-310), Bureau of Compliance, Food and Drug Administration, 200 C St. SW., Washington, D. C. 20204.

The Workshop was held February 7-9, 1968, to discuss administrative and technical problems, review current research and technical developments, and consider proposals for changes in the "Manual of Recommended Practice for Sanitary Control of the Shellfish Industry."

This report, based on the papers presented, includes a verbatim transcript of the proceedings. The workshop dealt with market standards, refrigeration, sewage outfalls, depuration, imports, and waste dumping at sea and its effects on continental shelf resources.

The report includes the guides for pesticides, radionuclides and ciguatera-like toxins in shellfish adopted for inclusion in the Manual.

SOCIO-ECONOMIC RESEARCH

"An Evaluation of Lake Trout Ice Fishing on Three New Hampshire Lakes," by Robert H. Forste, Research Report No. 6, New Hampshire Agricultural Experiment Station, Durham, New Hampshire, January 1969, 16 pp., illus.

The report analyzes data on value of equipment and expenditures associated with the fishery. It identifies selected social characteristics of the fishermen, and some characteristics of the fishery itself. Mr. Forste also describes his methodology and statistical procedures.

TROUT

"Trout Streams," by Paul R. Needham, annotated by Carl E. Bond, Holden-Day, Inc., 500 Sansome St., San Francisco, Calif. 94111, 241 pp., illus., $8.50.

This classic guide to trout and the streams in which they live was first published in 1938. It contains a wealth of information as pertinent now as the day it was written. The annotations cover the advances in fishery research and management made in the intervening 30 years. The notes both complement the text and refer the reader to sources of additional information. Scientific nomenclature has been brought up to date. The result is a single reference bringing together the most reliable and up-to-date information on trout, trout foods, and stream biology.

THE FOLLOWING PUBLICATIONS ARE AVAILABLE FROM PUBLICATIONS UNIT, BCF, 1801 N. MOORE ST., ARLINGTON, VIRGINIA 22209:

FISH & CRAB MEALS

"Value of Menhaden, Brevoortia tyrannus, Meal as a Protein Supplement to Cottonseed-Corn Diets for Pigs," by Robert R. Kifer and Edgar P. Young, "Fishery Industrial Research," Vol. 5, No. 4, pp. 133-142.

Although cottonseed meal has been used successfully in pig diets as a protein supplement to corn, the quality of the protein in these tests apparently is not the best for growth. This paper describes the methods and results of studies made to determine the value of menhaden meal as a supplement to such diets.

"Relative Chemical Composition and nutritive Values of King Crab, Paralithodes camtschatcia, and Blue Crab, Callinectes sapidus," by Robert R. Kifer and Paul E. Bauersfeld, "Fishery Industrial Research," Vol. 5, No. 3, pp. 121-131.

Blue crab meal has a high supplementary nutritive value for poultry when combined with other protein supplements. Alaska king crabs often are harvested in such volume that quantities of processing waste are sufficient for reduction into meal. This report describes the suitability of king crab meal for use in broiler diets.

QUALITY CONTROL

"Evaluation of Muscle Hypoxanthine and Volatile Bases as Potential Quality Indices for Industrial Bottomfishes from the Gulf of Mexico," by Enrique J. Guardia and Gerhard J. Haas, "Fishery Industrial Research," Vol. 5, No. 3, pp. 117-120.

Croaker and Spot are the 2 fishes found most commonly in industrial bottomfish catches in the Gulf of Mexico. A hypoxanthine test can indicate the quality of both and, presumably, that of the whole catch. A test for volatile bases can not be used for freshness because total volatile bases do not increase until after the fish has been stored one week on ice. It can be used as an index of spoilage. The authors describe their material, methods, and results.

LIPIDS

"Use of Electron Paramagnetism in Research on Fish Lipids," by William T. Roubal, "Fishery Industrial Research," Vol. 5, No. 3, pp. 107-115, illus.

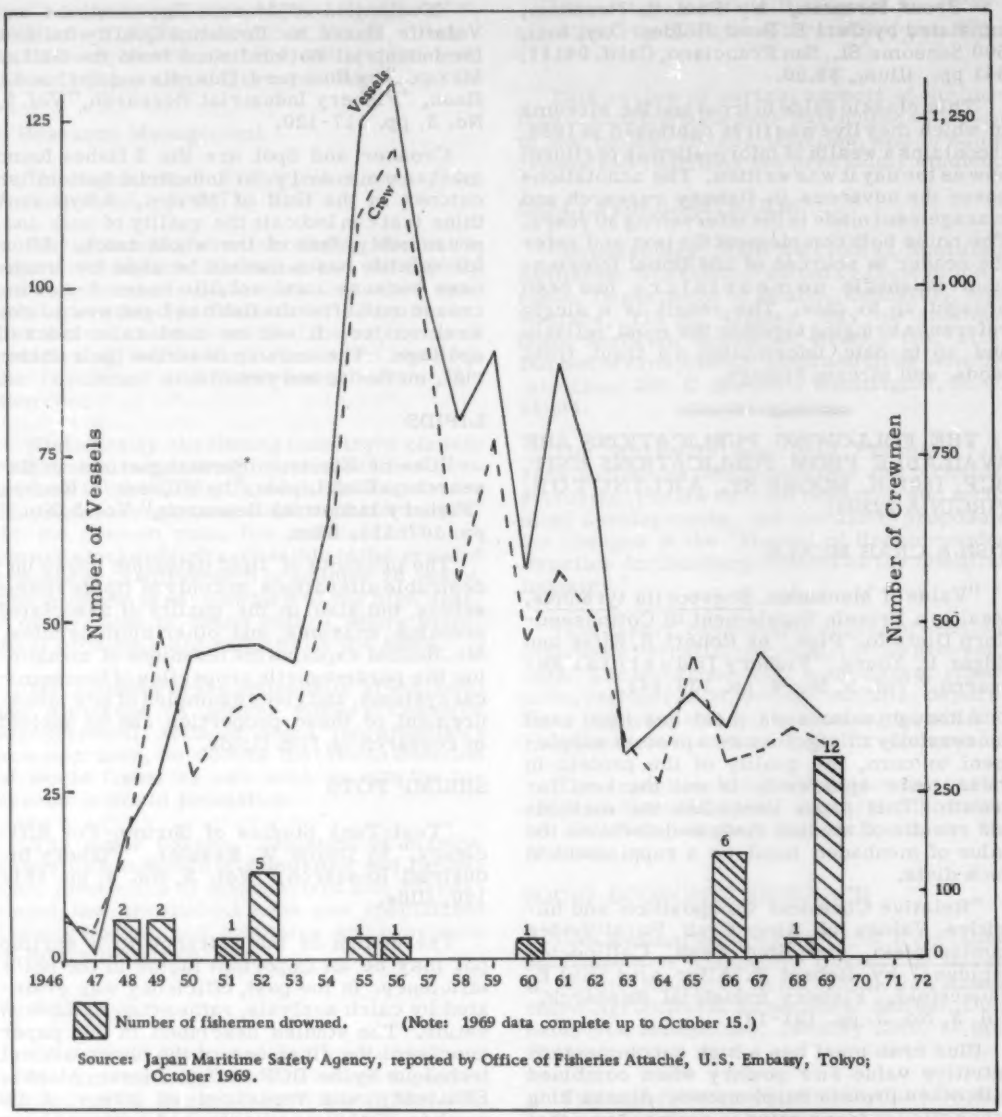
The products of lipid oxidation cause undesirable alterations, not only in lipids themselves, but also in the quality of associated proteins, enzymes, and other biomolecules. Mr. Roubal explains the technique of measuring the paramagnetic properties of biochemical systems, and gives examples of how measurement of these properties can be applied in research on fish lipids.

SHRIMP POTS

"Test-Tank Studies of Shrimp-Pot Efficiency," by Doyne W. Kessler, "Fishery Industrial Research," Vol. 5, No. 4, pp. 151-160, illus.

The design of the entrance to a shrimp pot may be an important factor in the pot's efficiency. In the past, efficiency was evaluated by catch analysis, rather than by observation. The studies described in this paper represent the first use of the observational technique by the BCF staff at Juneau, Alaska. Efficiency was measured in terms of the number of shrimp entering and escaping pots with different types of entrances.

--Barbara Lundy



Japanese fishing vessels and crewmen seized by Soviets, 1946-1969.

(See p. 68: "Soviets Seize Japanese Vessels")

INTERNATIONAL

WORLD FISHING IN 1968 SET RECORD

In 1968, the world's fishermen caught a record 64 million metric tons; the 1967 figure was 60,700,000 tons. The Food and Agriculture Organization reported these data on Dec. 7, 1969.

The 1968 total included 7,400,000 tons of fish from rivers, lakes, ponds, and other inland waters, an increase of 100,000 tons.

The marine catch--fish, crustaceans, molluscs, and other marine animals--was 56,600,000 tons. The 1967 total was 53,400,000 tons.

The estimates, based on official data, are reported in the new 'Yearbook of Fishery Statistics, Catches and Landings, 1968,' Volume 24, published by FAO's Department of Fisheries.

Peru No. 1

Peru was No. 1 again with a record 10,520,300 tons; her catch was 10,133,700 tons in 1967. Almost all of it was anchoveta--converted into fishmeal for export.

Japan was second with 8,669,800 tons (7,850,400 tons in 1967). The USSR, No. 3, reported 6,082,100 tons--the first time she exceeded 6 million tons. (The 1967 Soviet catch was about 5,777,100 tons.) Mainland China was fourth with 5,800,000 tons. The figure was based on a 1960 estimate because no recent figures were available.

Norway was fifth with 2,800,100 tons, a drop from the 3,268,700 tons of 1967. The United States followed with 2,442,000 tons. This was only slightly over the 2,430,500 tons of 1967.

Then followed the Republic of South Africa with over 2,000,000 tons; Denmark and the Faroe Islands, 1,633,100 tons; India, 1,526,000 tons; Spain, 1,503,100 tons; Canada, 1,490,300 tons; Chile, 1,376,100 tons; Indonesia, 1,175,800 tons; Thailand, 1,088,000 tons; and the United Kingdom, 1,040,300 tons.

Iceland dropped to 600,700 tons in 1968. She had caught 1,240,000 tons in 1966 and almost 900,000 tons in 1967. Between 500,000 and 1,000,000 tons were: Republic of China, France, Federal Republic of Germany, Portugal, Republic of Korea, and North Korea.

About 26 other countries reported 1968 catches between 100,000 and 500,000 tons. The remainder caught fewer than 100,000 tons.

Catches by Continents

All continents showed significant catch increases except Europe, excluding the USSR.

Asia led with 24,250,000 tons, up from 22,590,000 in 1967. South America was second with 12,880,000 tons (12,130,000 tons in 1967). Europe was third with 11,800,000 tons (11,900,000 tons in 1967). North America had 4,570,000 tons (4,430,000 tons in 1967); Africa 4,220,000 tons (3,730,000 tons), and Oceania, 210,000 tons (200,000 tons).

Catches by Species

Almost a third of the 1968 catch were Peruvian anchoveta, sardinellas, pilchards, North Pacific herring, and oil sardines. These totaled 20,500,000 tons, an increase of 900,000 tons above 1967.

Catches of the mackerel species reached a record 2,300,000 tons, compared with 2,000,000 tons in 1967. Cods, hakes, and haddocks were a record 9,500,000 tons, an increase of almost 1,300,000 tons. Increases were recorded in Alaska pollock, Atlantic cod, and Cape hakes; but Patagonian hake dropped from 600,000 tons in 1967 to fewer than 200,000 tons in 1968.

Flatfish, such as flounders, halibut, soles, and tonguefishes, totaled 1,200,000 tons. Redfishes, basses, congers, croakers, drums, sand eels, and porgies remained stable at 3,200,000 tons. Stable, too, were catches of amberjacks, horse and jack mackerels, and scads; for the past 6 years these have stayed at 2,000,000.

The catch of albacore, bigeye, bluefin, bonito, skipjack, and yellowfin tuna remained about 1,400,000 tons.

Sharks and rays appeared to be leveling off between 400,000 and 500,000 tons.

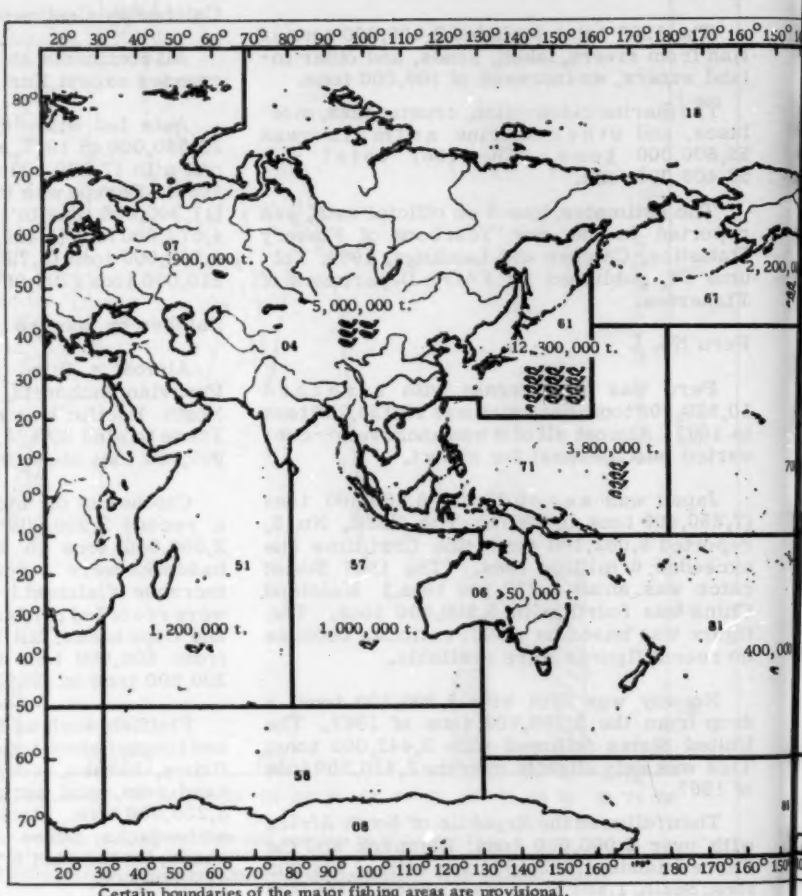
1968 WORLD CATCH BY

INLAND WATERS

01 Africa
02 America, North
03 America, South
04 Asia
05 Europe
06 Oceania
07 USSR
08 (Antarctic)

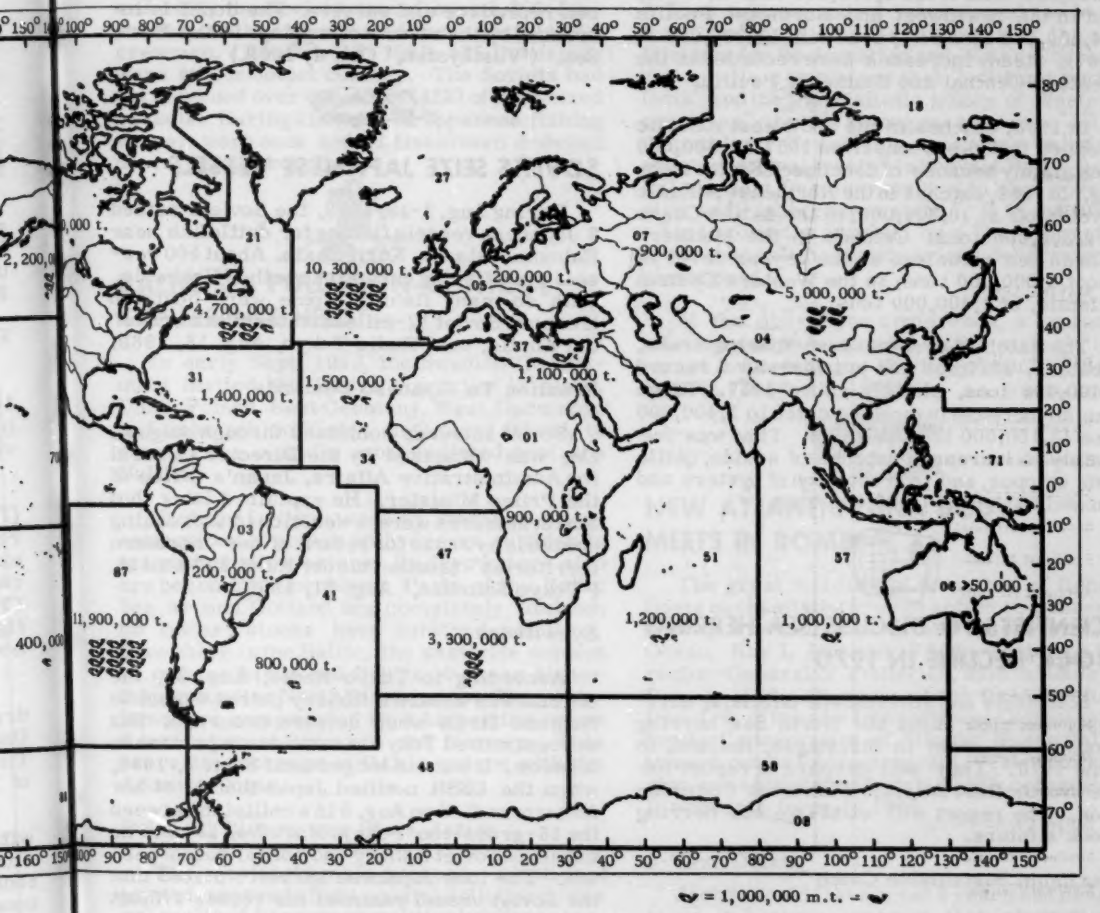
MARINE AREAS

18 Arctic
21 Northwest Atlantic
27 Northeast Atlantic
31 Western Central Atlantic
34 Eastern Central Atlantic
37 Mediterranean and Black Sea
41 Southwest Atlantic
47 Southeast Atlantic
48 Antarctic Atlantic
51 Western Indian Ocean
57 Eastern Indian Ocean
58 Antarctic Indian Ocean
61 Northwest Pacific
67 Northeast Pacific
71 Western Central Pacific
77 Eastern Central Pacific
81 Southwest Pacific
87 Southeast Pacific
88 Antarctic Pacific



Certain boundaries of the major fishing areas are provisional, particularly those in the Indian and Pacific Oceans.

MAJOR FISHING AREAS (FAO)



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Catches by Sea Areas

The FAO Yearbook also showed the distribution of catches by areas. The Northwest Atlantic yielded a record 4,700,000 tons, compared with 1967's 4,000,000 tons. Catches increased also in the Eastern Central Atlantic (up to 1,500,000 tons from the 1,000,000 of 1965); in the Southeast Atlantic (up to 3,300,000 tons from 2,600,000 tons in 1967); and in the Northwest and Northeast Pacific (14,500,000 tons compared with 13,800,000 in 1967). Steady increases were recorded in the Western Central and Southeast Pacific.

In 1968, catches in the Southwest Atlantic dropped to 800,000 tons from 1967's 1,300,000 tons mainly because of decreased Soviet fishing. In 1968, catches in the Northeast Atlantic leveled off at 10,300,000; in the Indian Ocean at 2,200,000 tons. Catches in the Mediterranean Sea remained at the 5-year level of about 1,000,000 tons; in the Western Central Atlantic, at 1,400,000 tons.

The catch of crustaceans--marine crabs, lobsters, shrimps and prawns--hit a record 1,400,000 tons, slightly above 1967. There was an increase in mollusc catch to 3,400,000 tons (3,100,000 tons in 1967). This was due mainly to increased catches of squids, cuttle fish, octopus, and to production of oysters and mussels at about 1,000,000 tons.

SCIENTISTS TO DISCUSS SEA HERRING STOCK DECLINE IN 1970

Scientists and government officials, seriously worried about the North Sea herring stocks, will meet in the Hague, Holland, in June 1970. They will prepare a report for the North-East Atlantic Fisheries Commission. The report will outline the herring stock's future.

Maximum Sustainable Catch

An international plan adopted years ago said the North Sea herring stock could withstand an annual catch of up to 800,000 metric tons. Later, this limit was exceeded and a sharp decrease in the herring fishery resulted. It was impossible for fishermen to find the fish. The herring reappeared slowly.

Larger Vessels & Better Gear

Larger vessels and more effective gear, such as purse-seine nets, caught younger and younger year-classes. It became possible to maintain a fishery of about 800,000 tons.

However, a significant decrease in herring stock in recent years makes observers feel that the stock has become so weak it no longer can reproduce and survive. The doubt is increased by the results of taggings in the North Sea. ('Vestkysten,' Oct. 4, 1969.)

SOVIETS SEIZE JAPANESE VESSELS

During Aug. 7-12, 1969, the Soviets seized 8 Japanese vessels fishing for cuttlefish near Habomai Islands, Kuril Chain. About 500 vessels were fishing cuttlefish north of Hokkaido. With so many fishing, some were bound to trespass Soviet 12-mile territorial waters off the Kurils, said Radio Tokyo, Aug. 16, 1969.

Reaction To Japanese Demands

Soviet seizures continued through August. One was witnessed by the Director General for Administrative Affairs, Japan's Office of the Prime Minister. He explained later that Soviet seizures were a reaction to increasing demands by Japan for return of her "northern territories" (southernmost Kuril Islands). ('Tokyo Shimbun,' Aug. 21, 1969.)

Eyewitness

According to Tokyo Radio, Aug. 21, the official was aboard a fishery patrol vessel in Nemuro Strait when seizure occurred. His account moved Tokyo to consider a protest to Moscow. It was not lodged until Sept. 2, 1969, when the USSR notified Japan that 11 of her fishermen died on Aug. 9 in a collision between the 16-gross-ton 'Fukuju Maru No. 13' and an unnamed Soviet fishery and border patrol vessel. The lone Japanese survivor stated that the Soviet vessel rammed his vessel without warning.

Japanese Protest

The Japanese protested that the USSR had failed to report incident for 20 days despite a clause in Soviet-Japanese Consular Treaty.

The treaty states that in case of marine accidents both countries are "mutually obligated to inform each other immediately." ('Washington Post,' Sept. 12, 1969.)

Startling Record of Seizures

The situation is serious. Startling figures obtained recently by Regional Fisheries Attaché, U.S. Embassy, Tokyo, from Japan's Maritime Safety Agency, show: Between 1946 and 1969, the Soviets seized over 1,300 Japanese vessels and arrested more than 11,000 crewmen. By Oct. 15, 1969, 135 fishermen were still in Soviet custody. The Soviets had not returned over one-third (482) of the seized vessels. During 1946-69, 21 Japanese fishing vessels were sunk and 32 fishermen drowned during Soviet seizures.

BALTIC SEA POLLUTION-CONTROL CONFERENCE HELD

In early Sept. 1969, the Swedish Government invited the Baltic countries (Finland, USSR, Poland, East Germany, West Germany, and Denmark) to Visby, on Gotland Island, to discuss the world's most polluted sea: the Baltic.

This sea is threatened by increasing concentrations of poisonous hydrogen sulfides in stagnant shallow waters. Its deep waters also are becoming a problem. Parts of the Baltic Sea around Gotland are completely lifeless: no fishery stocks have survived pollution. Elsewhere in the Baltic, the pesticide content in marine birds and fish is 10 times higher than in similar North Sea animals. The problems are compounded by a high-lying ocean floor between Denmark and Norway. This prevents exchange of Baltic waters with the Atlantic Ocean.

Political Differences Block Action

The meeting's main purpose--adoption of joint measures to fight coastal pollution--was not realized because of political differences. The East European countries wanted a high-level, ministerial follow-up (implying diplomatic recognition of East Germany), while the Western countries favored a simple "administrative approach." So the conference results were inconclusive.

"Nothing practical ensued," reported the research director of Sweden's Board of Nature Conservation ('New York Times,' Oct. 26, 1969).

Soviet Comments

Soviet sources confirm the 'Times' story. The 'Komunist Armenii,' on Sept. 28, said the Baltic's oxygen content is 2.5 times "below the normal content," even in "open waters." A Tass correspondent interviewed the head Soviet delegate, Ivan Borodavchenko, Deputy Minister for Reclamation and Water Conservation. He complained that "political problems" and the "unrealistic policy of Western countries" prevent strong measures to solve the problem. He said it is necessary to "sign an international treaty" to prevent Baltic pollution. East Germany must sign as a sovereign and "independent state." It is not possible to solve the problem on a "bureaucratic level when only heads of various departments participate."

At the end of the conference, a protocol was signed expressing the Baltic states' "interest in keeping the Baltic clean." ('Sov. Latviia,' Sept. 18, 1969.)

NEW ATLANTIC TUNA BODY MEETS IN ROME

The great mobility of tunas and of fishing fleets necessitates prompt action to conserve heavily fished tuna stocks in the Atlantic Ocean, Roy I. Jackson, FAO's Assistant Director-General of Fisheries, said in Rome on Dec. 1, 1969. He spoke at the first meeting, Dec. 1-6, of the new International Commission for the Conservation of Atlantic Tunas called to work out its future program. The commission was established under a 1966 convention. It went into force in 1969.

8-Year Delay

Jackson said that almost 8 years had passed since it became apparent that international action was needed to conserve Atlantic tuna stocks. In that time, tuna fishing there had increased from 292,000 metric tons in 1961 to 382,000 tons in 1968 and was still increasing.

The commission was formed because experts of several nations recognized that certain stocks were being heavily fished and that there would be increasing pressure in the future. It was formed "with the hope that the problems which the tuna fisheries of the Atlantic are presently facing and which endanger its future may be solved."

Tuna & Vessel Mobility

Jackson noted the great mobility of some tuna stocks, which migrate from ocean to ocean. He said that "tuna fishing vessels themselves are becoming more and more mobile and can move rapidly to more profitable fishing grounds."

He added: "This mobility of the fish themselves as well as the fishing fleets necessitate close cooperation between international and national bodies in order that effective conservation methods may be devised."

He urged attention also to the problem of overconcentration of fishing on particular stocks. He suggested that the commission give high priority to assessment studies. And he hoped for close cooperation between the commission and FAO, which helped to draft the tuna convention. It was signed in Rio de Janeiro, Brazil, in May 1966.

Rome Conference

At its Rome session, the commission considered proposals to study tuna and tuna-like populations, statistics and research, enforcement of recommendations, relationships with other international organizations, and a permanent site.

JAPAN-USSR DISCUSS DECLINE OF PACIFIC SAURY STOCKS

The 2nd Japan-USSR scientific meeting on northwest Pacific saury resource was held in Tokyo, Nov. 4-8, 1969. Their scientists agreed that saury resource has declined. They attributed this primarily to poor reproduction during past few years. However, as during 1968 meeting, they disagreed on population and age structures of saury.

Disagreement

The Japanese believe the northwest Pacific saury population consists of 2 groups: one spawns in spring, the other in fall. The large fish are 2-year-olds spawned in fall; medium are 1.5-year-olds spawned in spring; small fish are 1-year-olds spawned in fall.

The Soviets pointed out there was only one group, which spawns in the winter. They estimated large fish to be 3.5 years old, medium 2.5 years old, and small 1.5 years old.

Soviet & Japanese Interpretations

The Soviets explained that the resource's decline is due largely to overfishing. They cautioned that taking large fish would prevent adequate spawning. They noted that mackerel and saury compete for food, and that mackerel eat saury larvae and contribute to decline.

The Japanese blamed decline more on natural loss, and advised against taking small fish.

The 3rd meeting will be held in the Soviet Union. ('Shin Suisan Shimbun Sokuho,' Nov. 11, 1969.)

EUROPE

USSR

ARTIFICIAL SATELLITES USED FOR MARINE RESEARCH

The Soviets have been using artificial satellites for oceanographic and marine-resources studies, according to TASS. The press agency announced on Oct. 12, 1969, that experiments during the flights of Soyuz 6, 7, and 8 showed "it would be possible to change the climate of the planet and to use correctly its resources."

Space-Flight Data

In the next 2 days, more information became available, including photographs of "characteristic sections of the Earth surface....cyclones and cloud formations." The Soyuz-7 crew photographed the Caspian Sea--the test area for aerospace-oceanography experiments.

Ground tracking stations in Soviet territory and 7 research vessels of the Academy of Sciences continuously received and processed information from the spaceships and kept in contact with their crews.

In the first 42 hours in orbit, Soyuz 6 and 7 made successful "observations of. . .our country carried out simultaneously from Soyuz-6, from an aircraft, and from ground stations."

Program Objectives

Aleksei Konstantinov, space scientist of the Soviet Academy of Sciences, said the objective was to "determine correction coefficients necessary to move from experiments carried out with aircraft to experiments in orbit with an artificial satellite."

When analyzed, data would be used in "elaborating geological and geographical maps, both for our own country and for our planet in general." The data also would be used ". . .in other fields of the national economy, such as in the study of the wealth of the world's oceans."

* * *

NEW WASTE-WATER FILTER IS DESIGNED

A new waste-water filter for medium trawlers prevents pollution by oil products. The filter is a sand box that retains oil impurities by combining with them. It can process 300-400 kilos of water per hour.

The filter is 90x72x47 cm. and weighs 50 kilos. It will be introduced into all vessels of the Soviet Western Fisheries Administration's Tallin Trawler Fleet Base. ('Rybnoe Khoziaistvo,' No. 9, 1969.)

1954 International Convention

The new filter meets the requirement of the 1954 international convention to prevent oil pollution of sea water. The convention prohibits dumping waste water containing more than 100 milligrams of oil per liter.

Inadequate Production

The Soviet industry does not produce enough conventional waste-water filters; also, these cannot be used aboard medium trawlers because they are too bulky and heavy.

SPAIN

FISHING FLEET GROWS

Larger Spanish trawlers and freezers with increased fishing capabilities continue to enter the fisheries. Since 1964, the government has authorized official credits and tax rebates to construct vessels; special loans are available for large vessels. The objective is to promote development of a modern fleet of about 600,000 gross registered tons (GRT) by the end of 1970. This is considered sufficient for an average annual catch of about 1,500,000 metric tons of fish.

Distant-Water Fleet

The fleet's long-range sectors, trawling cod in the Northwest Atlantic and fishing hake in the South Atlantic, have made sizable gains (Table 1).

Spain began producing frozen fish relatively late but, since 1960, this part of fleet has

SPAIN (Contd.):

Table 1 - Spain: Fishing Fleet, 1965-68
(000 Gross Registered Tons)

Tonnage Group	1965	1966	1967	1968	Objective 1970
Over 250 GRT	135.9	155.3	193.6	216.5	250
20-250 GRT	307.0	313.5	328.3	339.7	350
Total	442.9	468.8	521.9	556.2	600

developed rapidly. At the end of 1967, 103 modern freezer trawlers of 82,803 GRT were operating. Of these, 55 were put into service between 1963 and 1966, and about 48 vessels in 1967 and 1968. Many others are under construction and will enter the fisheries in 1969 and 1970; many replace smaller, old vessels.

Codfish Fleet

The codfish fleet in 1968 also had increased: to 26 trawlers and 126 pair trawlers totaling 58,955 GRT. These operated exclusively on the fishing grounds of Northwest Atlantic (Greenland, Labrador, Newfoundland, and Nova Scotia). Their catches were 95% cod.

Freezer Trawlers

In 1968, catches by freezer trawlers were 240,000 metric tons, almost 5 times 1964 catch (Table 2). Catches frequently were greater than home demand, so shipowners restricted output and limited catches. In 1969, shipowners turned increasingly toward greater export markets for some products. This fleet operated mainly in Southeast Atlantic off Africa. Catches included 80% hake.

Table 2 - Spain: Estimated Catch by Fleet, 1964-68
(In 000 Metric Tons)

Type of Fleet	1964	1965	1966	1967	1968
Long-range fleet:					
Freezer vessels	53	133	195	230	240
Codfish vessels	231	234	239	290	340
Medium & coastal	746	744	690	690	680
Other	170	229	221	229	240
Total	1,200	1,340	1,345	1,439	1,500

Cod Catch

Cod trawlers caught 340,000 tons, up 109,000 tons, about 50%, above 1964. This fleet operated in Northwest Atlantic, where catches were 95% cod.

Government Plans

The fleet appears to be nearing its objective and may exceed goal set by initial plan. The government plans to restrict increase of freezer fleet, grant no official aid to construct conventional cod vessels used only for salting cod, develop deep-water tuna fleet, concentrate on modernizing small coastal fleet, and improve marketing. (Reg. Fish. Attaché, Europe, Nov. 25, 1969.)

SWEDEN

FISHING INDUSTRY FUTURE IS NOT PROMISING

For the fourth successive year, Sweden's fishing industry faces great difficulties. Until 1965, profits trended upward. Since then, catches and income have gradually decreased, affecting owners of larger boats in particular.

In 1968, Swedish fishermen landed 307,172 metric tons of fish worth 218.1 million kronor,[1/] the lowest quantity since 1962 and lowest value since 1963.

While other workers have received more pay each year, the estimated fishermen's income in 1969 will be only a little more than half of what they earned in 1965. The industry's prospects are not promising.

Recent Developments

In 1962, Swedish fishermen caught two-thirds of domestic consumption; now imported fish are the larger part. Since 1965, import of fish and fish products have more than doubled. In 1968, these totaled 72,900 metric tons worth 279 million kronor.

Norway, Denmark, and Iceland, the main suppliers, account for 73% or 204 million kronor, of total imports. Imports from Canada, tripled since 1967, reached 21 million kronor. This expansion was attributed to a large increase in shrimp imports. However, 90% of this reportedly is U.S. shrimp exported from Canadian ports. Direct imports from U.S. declined 5 million kronor to 9.2 million kronor. This was because less canned crab meat was imported, whereas its import from Japan and Soviet Union rose 5 and 3 million kronor, to 8.4 and 15.2 million kronor.

Foreign Trade

In 1968, total foreign trade in fish and fish products resulted in import surplus of 154

1/Skr. 5.17 equal US$1.

SWEDEN (Contd.):

million kronor. Export quantities dropped 7% from 1967 and totaled 187,600 metric tons, although value stayed at 124.5 million kronor.

Exports to Denmark were 75% of total value and 93% of quantity. To a large extent, these were direct landings by Swedish fishermen in Danish ports.

Swedish fishermen prefer to land larger part of herring catches in Danish ports for 2 reasons: shorter distances from fishing grounds, and Denmark has efficient processing industry and is convenient for shipments to West Germany.

In 1968, imports of frozen fish fillets were 44% of Swedish fish consumption by weight. They increased during 10-year period from 4,000 metric tons to 14,000 metric tons worth almost 50 million kronor. The European Free Trade Association (EFTA) agreement has removed the import protection Swedish fishermen had enjoyed.

Fewer Fishermen

Reduced income has reduced number of fishermen. This is not exceptional in an industrialized country where agriculture and fishing employ less of the work force. Among young fishermen on west coast, the industry center, 18% under 40 years switched in 1968 to other employment. For over 40, rate was 6%.

Jellyfish Invasion

The invasion of jellyfish (medusa Tima Bairdii) in recent years has hit shrimp fishermen especially hard. During certain periods, the jellyfish have stopped shrimp fishing entirely. Trawls were quickly filled and became so heavy they split, or caused enormous workload in sorting out the shrimp. Swedish researchers claim that inflow of cold water from North Sea has caused invasion.

Nordic Economic Union

The report and draft treaty covering fishery policy for Nordic economic union (NORDEK) has been criticized by National Fisheries Board and fishermen's organizations. The present proposal would abolish all restrictions on trade in fishery products between Nordic countries on Jan. 1, 1972. Authorities claim abrupt removal of restrictions would seriously affect Swedish industry. They have proposed transition period of 5 years.

Norwegian Subsidies & NORDEK

Another serious problem for Swedish fisheries is Norwegian subsidies to fishing industry. These have been increased yearly and now are estimated at 30% of catch value. The NORDEK report states national support should not affect trade competition between Nordic countries, or exports to a third country. However, the report states that support can be given fishermen to promote social, economic, and political objectives. Swedish fishing organizations claim this leaves open possibility of continuing subsidies and, to a large extent, eliminates basis for common fishery policy.

Swedish Aid

Although Sweden is unwilling to subsidize fisheries, it provides some loans. From July 1, 1969, Swedish fishermen could apply for:

Consolidation loans: to assist fishermen with working capital problems, maximum 200,000 kronor, to be paid off during 10-year period.

Rationalization loans: to improve efficiency of fishing craft, maximum 200,000 kronor, 10-year period.

Conversion loans: aid to fishermen who have been continuously engaged in the industry during last 5 years and intend to take up another trade. Maximum 12,000 kronor, repayment required if recipients return to fishing within 2 years.

Gear loans: to assist fishermen who have lost gear, or whose gear has been damaged. Maximum: 15,000 kronor.

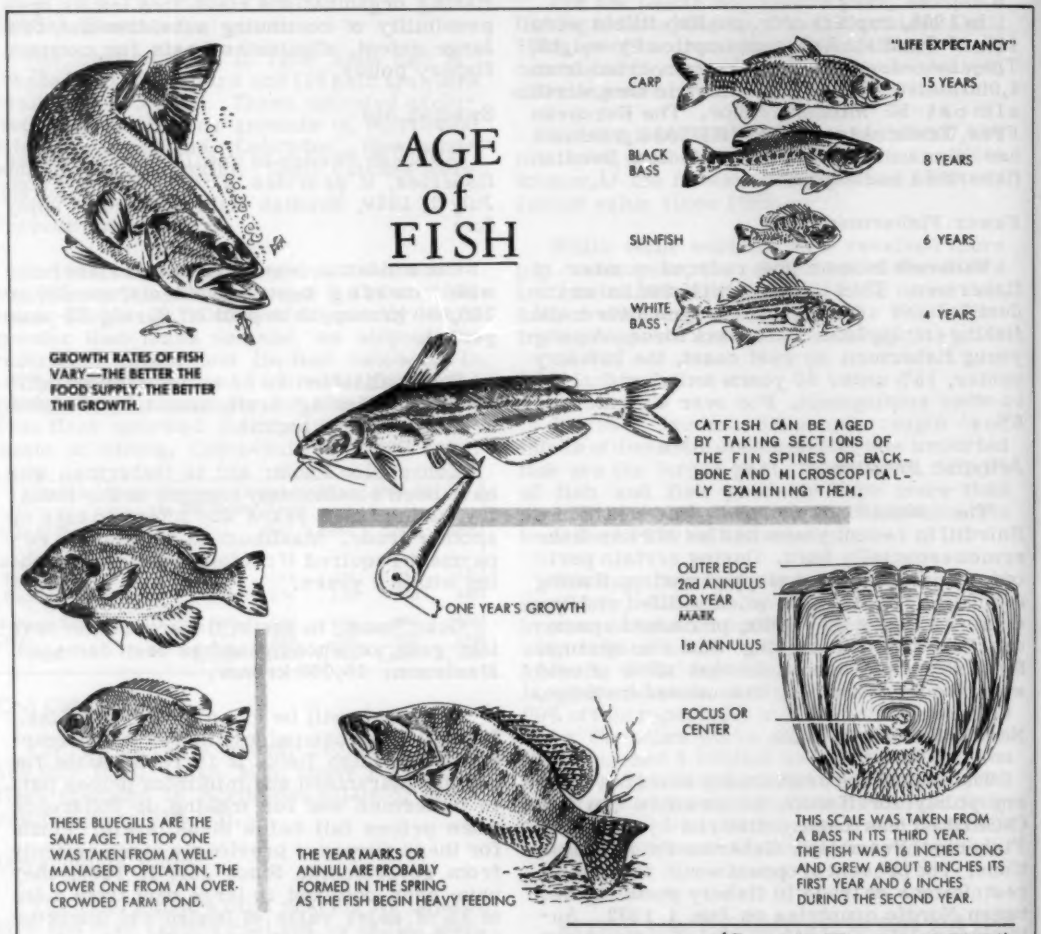
Other help will be given by 'Svensk Fisk.' It has started campaign to increase consumption of Swedish fish. It is responsible for setting guaranteed and minimum prices paid to fishermen and for making up difference when prices fall below these levels. Funds for these purposes previously came entirely from government. Since July 1, 1969, they have been obtained in large part from a fee of 3% of sales value of landed and imported cod, haddock, redfish, and saithe.

SWEDEN (Contd.):

OUTLOOK

The prospects for Swedish fisheries are not bright. The decline in number of fishermen probably will continue and could be accelerated if herring stocks decline further. Crew size will have to be cut to make fishing more profitable. There is a safety limit however. The government has no plans for subsidies to maintain present size of fishing fleet.

Imports of fish and fish products are expected to remain relatively high in the future. This should offer sales opportunities, especially for U.S. shrimp and fresh frozen salmon. (U.S. Consul, Goteborg, Dec. 4, 1969.)


AGE of FISH
"LIFE EXPECTANCY"
CARP
15 YEARS
BLACK BASS
8 YEARS
SUNFISH
6 YEARS
WHITE BASS
4 YEARS
GROWTH RATES OF FISH VARY—THE BETTER THE FOOD SUPPLY, THE BETTER THE GROWTH.
CATFISH CAN BE AGED BY TAKING SECTIONS OF THE FIN SPINES OR BACK-BONE AND MICROSCOPICALLY EXAMINING THEM.
ONE YEAR'S GROWTH
OUTER EDGE
2nd ANNULUS OR YEAR MARK
1st ANNULUS
FOCUS OR CENTER
THESE BLUEGILLS ARE THE SAME AGE. THE TOP ONE WAS TAKEN FROM A WELL-MANAGED POPULATION, THE LOWER ONE FROM AN OVER-CROWDED FARM POND.
THE YEAR MARKS OR ANNULI ARE PROBABLY FORMED IN THE SPRING AS THE FISH BEGIN HEAVY FEEDING
THIS SCALE WAS TAKEN FROM A BASS IN ITS THIRD YEAR. THE FISH WAS 16 INCHES LONG AND GREW ABOUT 8 INCHES ITS FIRST YEAR AND 6 INCHES DURING THE SECOND YEAR.

(Georgia 'Game and Fish')

LATIN AMERICA

CHILE

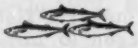
SEEKS JAPANESE ADVICE ON SAURY FISHING

The Chilean Institute for the Study of Fishery Problems has asked guidance from a large firm in Japan on these aspects of the Japanese method of saury fishing: (1) converting anchovy purse seiners for saury fishing; (2) method of freezing and packing catch and (3) fish size used for tuna bait.

Plans Saury Fishery

Apparently, Chile plans to harvest the unexploited saury off her coast and export them as tuna bait to Japan, where bait saury is in short supply due to poor fishing.

The size of saury resource off Chile is estimated by FAO to be at least 50 million metric tons. ('Nihon Suisan Shimbun,' Nov. 7, 1969.)



ECUADOR

REPORT OF NEW SHRIMP BEDS IS PREMATURE

New information indicates that Oct. 1969 announcement of substantial new shrimp beds off Ecuador was overly optimistic.

The U.S. Consulate, Guayaquil, originally reported new beds 30 miles offshore in 40 to 100 fathoms and extending from Manta south. Catches up to 30,000 pounds for a single boat in 2 days fishing were reported.

Shrimp Disappeared

During late Sept.-early Oct. 1969, 90 vessels fished the new area and caught about 200,000 pounds. The shrimp disappeared after 3 weeks' fishing.

Good Year Nonetheless

Despite this failure, 1969 looked like a good shrimp year. The catch was up considerably over 1968. Exports for first 8 months were 6.2 million pounds, compared to 4.5 million pounds for 1968 period. According to industry sources, the reason for increased catch is better boats and more intense fishing. (U.S. Consulate, Guayaquil, Nov. 19, 1969.)

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BRITISH HONDURAS

FISHERY EXPORTS RISE

The reported value of British Honduras' 1968 fishery exports was US$0.6 million, over 33% more than in 1967. Shipments continued high in 1969.

Exports of spiny lobster tail accounted for roughly two-thirds of the 1968 earnings. These exports now are being more accurately valued and will probably total more than US$1 million annually.

Conch Exports Up

Conch exports are up substantially. With 543,000 lbs. shipped through August 1969, they were up more than 50% over first 8 months of 1968.

In the long run, however, major expansion can occur only in fin fish or in fish farming. These probably will require foreign capital and organization. (U.S. Consulate, Belize City, Oct. 31, 1969.)

SOUTH PACIFIC

AMERICAN SAMOA

TUNA PRICES INCREASED IN NOV. 1969

Japanese tuna suppliers and U.S. packers at American Samoa increased prices for November 1969 tuna deliveries to that island by US$10 a ton for albacore, and $5 a ton for yellowfin. This was the first price increase since August 1969.

The new prices represent an all-time high for American Samoa (per short ton): round albacore: frozen $440, iced $425; gilled-and-gutted yellowfin: frozen $325.50, iced $332.50.

Japanese Fleet Dwindles

Price negotiations are conducted monthly between Japanese firms and Samoa-based U.S. packers. But the size of Japanese tuna fleet supplying the island has dwindled to 5-6 vessels compared with 70-75 South Korean and 55-60 Taiwanese vessels. So indications are that from 1970 the three countries, alternately, will conduct price negotiations with U.S. packers. ('Katsuo-maguro Tsushin,' Nov. 20, 1969.)

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JAPAN

FISH SHORTAGE TO BECOME ACUTE

By 1977, fish supplies will be short about 2,000,000 metric tons in Japan, according to the Coastal Fishing Promotion Council. Reporting to the Fisheries Agency, the council said a price rise in marine products would be unavoidable, unless substantial innovations were made in fishing technology.

Demand Exceeds Supply

In 1968, Japan produced 8,600,000 tons of marine products, excluding about 700,000 tons of imports, but demand was substantially higher than supply. Demand for shrimp and tuna had risen conspicuously because of rising living standards.

Long-Range Forecast

Domestic per-capita consumption of fish is expected to grow from 122 pounds (whole or round weight) in 1967 to 148 pounds in 1977.

Demand for fish and marine products would increase to 12,400,000 tons by 1977, including about 800,000 tons of seaweed, the council forecast.

However, supplies will be limited to about 8,900,000 tons of fish and shellfish and to about 2,000,000 by imports. ('Yomiori,' Oct. 28, 1969.)

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1969 E. BERING SEA CRAB OUTPUT EXCEEDS PLANS

In 1969, Bristol Bay crab production surpassed original plans. The factoryships 'Keiko Maru' (7,536 gross tons) and 'Koyo Maru' (7,758 gross tons) ended operations in late Sept. Their combined quota was 85,000 cases of king crabs, and 16 million tanner crabs.

Keiko Maru reached her king crab quota, packing 43,400 cases. Her tanner crab quota was 8.2 million crabs plus an allowance; actually, catch reached 9 million crabs: 4,600 metric tons were frozen shell on, 2,700 tons were canned, and 7 tons frozen shell on.

Koyo Maru Catches Quota

Koyo Maru had been assigned a quota of 41,600 cases of king crabs and 7.8 million tanner crabs plus an allowance. She packed her king crab quota and harvested 8.6 million tanner crabs (4,700 tons were frozen shell on and 10 tons shelled).

Both fleets experimented with shrink-packaging, using about 10% of the tanner crab catches. This method (heating and shrinking the meat before packaging) serves to increase the market value of tanner crab meat considerably. The factoryship owners are considering full-scale shrink-packaging of tanner crabs in 1970.

1969 Fishing Appraised

Keiko Maru fleet's tanner-crab fishing gear was 60% tangle nets and 40% crab pots; Koyo Maru fleet used about 50% each.

Both fleet commanders said they would like to increase pot gear in 1970; fishing and sea conditions were different in 1969: the more productive grounds were found on the southwestern part of Bristol Bay.

They found king-crab fishing poor in late spring, but it began to improve toward fall. Tanner crabs were large and more abundant than anticipated. ('Suisan Keizai Shimbun,' Oct. 27, 1969.)

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FISHERIES AGENCY EXPERIMENTS WITH PETROLEUM FISH FOOD

The Japanese Fisheries Agency is experimenting with production of synthetic petroleum protein as fish food. Projects are underway at 19 fishery experiment stations throughout Japan.

Petroleum protein is produced by micro-organic fermentation of liquid hydrocarbons. A solution of water, ammonia, dextrose, and other nutrients is seeded with pure cultures of yeast or bacteria. This mixture is introduced into a fermentation tank together with a paraffin feed-stock. Compressed air provides the necessary oxygen. The micro-organisms feed on the hydrocarbon molecules, converting them into living cells. These cells, harvested, dried and powdered, are the end product, usually referred to as single-cell protein (SCP).

High Growth Rates in Fish

In laboratory tests at stations in Nagano and Shizuoka prefectures, a compound of SCP

JAPAN (Contd.)

and fish meal produced excellent results in raising eel, rainbow trout and, particularly, carp. At a marine fish farm, 20,000 rainbow trout, fed a formula of SCP (yeast grown on paraffin), fish meal, bean pulp, various minerals, and cuttlefish flesh, gained weight in a relatively short period.

Mass Production of SCP

Judging from the remarkable results in preliminary experiments, the Agency believes that an annual production of 3,000,000 tons should be possible. This would equal about half the feed now imported. Coastal fishing enterprises, suffering from a feed shortage, would get a real 'shot in the arm' if this goal is achieved.

Private Industry Begins Production

Many private companies already have done considerable research on SCP. Several plan to start production in 1970. Kyowa Hakko has produced several thousand tons in test runs. It plans to achieve an annual production rate of more than 100,000 metric tons before the end of 1970.

Kanegafuchi Chemical also plans to begin annual production of 60,000 tons by the end of 1970.

Dai Nippon Ink and Chemical has been making several tons a month and expects to produce 12,000 tons a month.

Mitsui Toatsu hopes to begin producing about 1,500 tons a year in mid-1970.

Ashahi Chemical and Ajinomoto also are experimenting with SCP. ('Youmuri,' July 18; 'Chemical Week,' August 2; 'Food Engineering,' May 1969; 'Fish Trades Gazette,' Aug. 16, 1969.)

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EXPORTS MORE S. KOREAN & TAIWANESE TUNA

Tuna caught by South Korean and Taiwanese vessels and exported through Japanese trading firms during Jan.-Aug. 1969 were near 43,000 metric tons. This was reported by the Japanese Ministry of International Trade and Industry (MITI).

Record in 1969 Possible

If exports continued at July-Aug. 1969 level (averaged around 6,000 tons), 1969 sales of foreign-caught tuna would easily surpass 1968's 61,000 tons.

Exports by area showed 34,563 short tons shipped to U.S. and Canada, and 11,442 metric tons to Italy, Spain, France, etc.

In addition to exports approved by MITI, foreign-caught tuna are sold directly by overseas-based Japanese firms and some is brought back to Japan for re-export. So the actual quantity of "third nation" tuna exports handled by Japanese firms are believed far greater than MITI's figures. ('Suisancho Nippo,' Oct. 23, 1969.)

* * *

MORE WHALE MEAT NEEDED

Japanese domestic sales of frozen whale meat have been so good that all 72,538 metric tons produced during the 23rd Antarctic whaling season were sold to dealers. The 5,000 tons imported from USSR were selling well. The 39,234 tons produced during the 18th North Pacific whaling season probably would be sold as soon as the carriers returned to Japan. Such a favorable market has not been experienced before. The cost of storing the meat was less in 1969 than before.

Normal Supply Cycle

In the past, whaling companies did not exhaust the supply during the year. In the normal cycle, whale meat from the Antarctic landed in Japan February or March remained available until North Pacific whale meat appeared in the market in July or August. The supply of North Pacific whale meat lasted until appearance of whale meat from next Antarctic season. In 1969, however, all 3 whaling firms completed sales of Antarctic whale meat by end of April. By August all North Pacific whale meat had been sold.

Selling Price Rises Yearly

The selling price to wholesalers has increased each year. In 1969, it was about 26 U.S. cents a pound. The favorable market is due partly to shortage caused by reduced international whaling quotas.

The demand for whale meat in 1970 will depend on the supply of fish and pork. However, demand is expected to increase. Then Japan would have to increase her imports of whale meat from the Soviet Union, South Africa, or Peru. These countries now see Japan as potential market. ('Suisancho Nippo,' Sept. 12, 1969.)

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JAPAN (Contd.)

U.S. FIRMS MAY BUY WHALE OIL

Two U.S. fat-and-oil processing firms recently sent representatives to Japan to buy sperm whale oil. Soviet-produced sperm oil is in short supply in Europe. The 2 firms are seeking a stable source in Japan.

U.S. Demand

The U.S. representatives said a U.S. demand for 24,000-25,000 tons exists. They would like to obtain a stable supply of 15,000 to 18,000 tons from Japan--at cost, insurance, freight (c.i.f.) prices of around US$180 a ton.

European Market Improves

An agent for the British Unilever Company said in Japan that the fish and whale oil market in Europe was improving; U.S. menhaden oil was bringing about $150 a ton. He guessed that the fin whale oil price was around £80 c.i.f. (about US$191) a long ton. ('Suisan Tsushin,' Oct. 27, 1969.)

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3 FLEETS ARE WHALING IN ANTARCTIC

Three Japanese fleets began Antarctic whaling operations on Dec. 12, 1969. Japan has been assigned a national quota of 1,493 blue-whale units (BWUs) for the 1969/70 season.

The other active whaling nations, the USSR and Norway, have been assigned national quotas of 976 and 231 BWUs.

The overall quota--2,700 BWUs--set by the International Whaling Commission is 500 BWUs below 1968/69. ('Suisan Shuho,' Oct. 25, 1969.)

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TRAWLS OFF NEW YORK

In first-half 1969, 10 Japanese trawlers fished off New York.

The 3 companies involved did not detail results. They agreed that "catches in the area off New York are slightly better than off Africa but the trip to and from Las Palmas is costly. From an economic point of view, therefore, the two areas will be of equal value."

The Catch

The bulk of catch off New York was "yarika" (squid), "shizu" (butterfish), sea bream, herring, and hake. Price for squid, as high as US$550 a metric ton, supports the fishery in that area.

The 3 firms consider the New York area part of year-round operation. They fish octopus off Africa in summer, and squid off New York in winter. Two other companies are planning to send trawlers to the New York grounds. ('Shin Suisan Shimbun,' Sept. 12, 1969.)

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RESUMES EXPLORATORY FISHING IN NORTHEAST ATLANTIC

On April 15, 1969, Nichiro Gyogyo sent its stern trawler 'Akebono Maru No. 51' (1,454 gross tons) to Bay of Biscay and other northeast Atlantic areas on 3-month exploratory fishing trip. The firm planned a second survey of that region during December 1969-March 1970.

The first trip did not produce satisfactory results because of the unfavorable season.

Second Survey

The vessel will begin in Bay of Biscay seeking 'monko' squid, octopus, and snapper. It will proceed toward Shetland Islands, north of Scotland, where herring fishing was reported promising. Nichiro's survey is supported by a government subsidy of about US$222,000. ('Suisan Tsushin,' Nov. 19, 1969.)

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JAPAN (Contd.)

7 SHRIMP FIRMS FORM COMPANY IN SOUTH AMERICA

On Nov. 19, 1969, 7 Japanese fishery firms fishing shrimp off Guianas in northeastern South America formed South America Northern Coast Fishery Development Co. The company has authorized capital of about US$278,000 and paid-up capital of $69,400 to be invested equally by all partners.

To Invest in Plant

The firm plans to invest in shrimp-processing plant scheduled to be constructed in Georgetown, Guyana, by the British-owned Guyana Industry Holding Co. Plant will cost about $2.5 million. It will have freezing capacity of 100 tons a day, and cold-storage capacity of 1,000 tons. The British firm reportedly invited also the participation of U.S. shrimp vessel owners in the region.

Fleet Fishing Since 1963

Japanese firms have been fishing shrimp off Guianas since 1963. Their fleet consists of 69 shrimpers belonging to 7 firms: Nichiro, 24 vessels; Shinyo Gyogyo, 15; Yutaka Gyogyo, 10; Hokoku Suisan, Hakodate Kokai, Kagawa Godo Suisan, Nanbei Ebi Gyogyo--5 each.

Their catches, processed at shore plants in Georgetown, are either exported to U.S. or Japan. ('Minato Shimbun,' Nov. 23, 1969.)

* * *

ANTARCTIC KRILL FISHERY IS CONSIDERED

The Japanese Fisheries Agency is studying use of euphausia (krill) found in limitless quantities in the Antarctic. Krill is similar to a small shrimp growing to five centimeters in 2 years. They are abundant near surface along the Antarctic ice pack and are regarded only as food for whales.

Unlimited Stocks

Whale stocks have declined and so krill have increased explosively. The resource is estimated at 100 million metric tons with maximum sustainable yield of 500,000 tons. Because of limitless stocks, there will be no difficulty obtaining enough to process into food, but the problem lies in fishing method.

The Problems

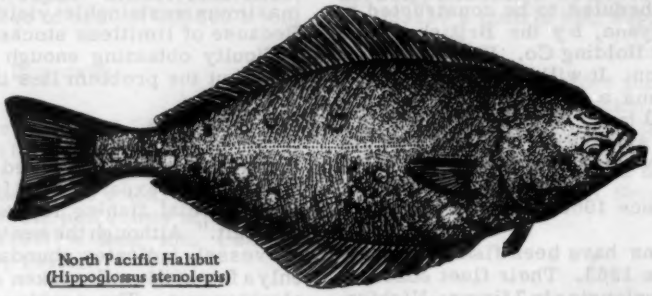
One company has offered to cooperate with the Agency in experimental fishing. They say "commercial fishing for euphausia will be difficult." Although the sea's red color ahead of vessel indicates abundance of plankton, only a few krill can be taken even with a large plankton net. The problem is that krill's swimming speed is faster than first thought. The surface and midwater trawls cannot be used.

Also, there are economic factors. It takes about one month to reach Antarctic ice pack from Japan via Pacific. ('Minato Shimbun,' Sept. 18, 1969.)

FOOD FISH FACTS

Halibut has been a popular food for people of northern countries since ancient times. Scandinavian fjords and Scottish firths provided halibut for the rugged, early settlers in those regions. The English thought highly of halibut and served it on holy days, calling it "holy-day butte." "Butte" was the middle English word for flatfish or flounder. Over the years "holy butte" evolved into halibut. In America, early explorers along the Pacific Coast found halibut highly prized by coastal Indians. Today, North Pacific halibut, the proud name of the king of flatfishes, is the main commercial source of true halibut.

Description: North Pacific halibut is the largest member of the flatfish family. Halibut matures at about 10 years and may live to be 50. Females, which grow larger than the males, often weigh from 150 to 200 pounds or more. Commercially, halibut is graded according to size: "chicken"--5 to 10 pounds; "medium"--10 to 60 pounds; "large"--60 to 80 pounds; and "whales"--80 pounds and over.



North Pacific Halibut
(Hippoglossus stenolepis)

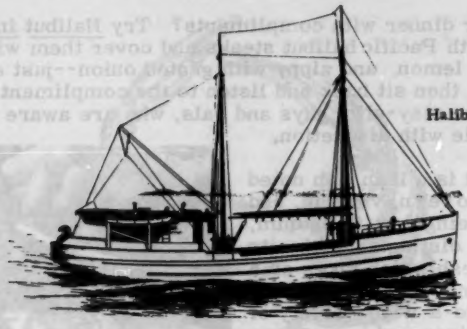
A curious fact about halibut, and other flatfishes, is the position of the eyes. They, like most fish, start life swimming upright and with eyes set wide apart. However, before they are an inch long, one eye, usually the left, begins migrating to the other side of the head and the fish begins to lean instead of swimming upright. Within a few days the migrating eye has moved nearly 120 degrees to join the right eye, and the fish swims with its eyeless side parallel to the bottom. The dark, top side of the flatfish allows it to hide in the sand or rocks and not be seen easily. The white, belly side blends with the light filtering down through the water, thus protecting it from enemies below. The mouth, distorted in the process of becoming a flatfish, wears a crooked, painted look.

Habitat: North Pacific halibut are taken along the continental shelf and slope of the North Pacific adjacent to Alaska, British Columbia in Canada, and off the shores of Washington State. Halibut was once taken from the cold waters of the Atlantic as well as the Pacific but, due to poor conservation methods in the past, Atlantic halibut has become scarce.

Halibut Fishing: North Pacific halibut is brought aboard the fishing vessel alive, dressed at sea, and stored immediately in ice. As soon as the fishing vessel reaches port, the halibut is rushed to processing plants where it is headed, graded for quality and size, and washed. Some of the halibut is packed in ice for fresh shipment to distant markets. Approximately 20 percent or more of the halibut is sold fresh. The bulk of the catch is frozen in -40° F. freezers. After freezing, the fish is glazed by being dipped several times in water at the freezing point. This builds up a jacket of ice over the entire fish and prevents dehydration or oxidation in storage. This process assures the consumer of a top-quality product.

(Continued page 81.)

FOOD FISH FACTS (Contd.)



Halibut Fishing Vessel

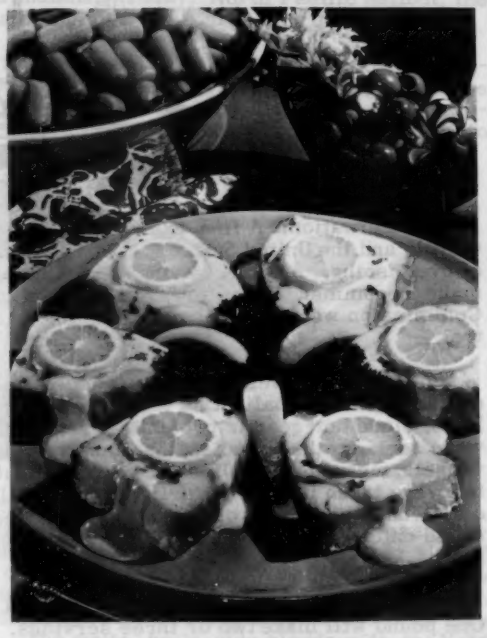
Conservation: A fine example of conservation through cooperation was exhibited by Canada and the United States in the early 1920's when the catch of halibut declined because of overfishing. An international commission was created to study the halibut fishery and make recommendations toward conservation. In 1930, the International Pacific Halibut Commission was formed and fishing for halibut by the two countries came under its control.

In 1967, however, the North Pacific halibut industry began to feel the effect of incidental catches of halibut by foreign and domestic trawlers. Halibut fishermen use longlines, since net-gear is prohibited, and catch 8- to 9-year old fish. Although the trawlers were seeking other species, the massive volume of their catches, especially by the foreign vessels, meant that millions of young halibut were caught and did not survive. Many halibut were taken before maturity also, as halibut do not spawn until they are 8 to 16 years old. Thus the effects of the trawler catches of young halibut has resulted in greatly reduced catches for the halibut fishermen. Negotiations are underway to correct this problem.

Use of Halibut: North Pacific halibut is usually sold as steaks, either fresh or frozen. One pound will make two or three servings. Halibut is an excellent source of high-quality protein and minerals while being low in sodium, fat, and calories. The true North Pacific halibut, which has lean, white, tender flesh with a mild flavor, should not be confused with other species of fish which are sometimes sold as halibut. Ask for true North Pacific halibut at your seafood counter. (Source: National Marketing Services Office, BCF, U.S. Dept. of the Interior, 100 East Ohio, Rm. 526, Chicago, Ill. 60611.)

HEY DIETERS--CHEAT A LITTLE!

Want to crown your dinner with compliments? Try Halibut in Lemon Cream Sauce. Buy tender and tasty North Pacific halibut steaks and cover them with a sauce that is rich with cream, tangy with lemon, and zippy with grated onion--just enough to bring out the flavor. Bake and serve, then sit back and listen to the compliments. With this quick and easy recipe from BCF, the stay-slim guys and gals, who are aware of calories but love to eat well, can cheat a little with discretion.



North Pacific halibut is a lean fish noted for its energy-giving protein, vitamin, and mineral content while being low in sodium, fat, and calories. It is distinguished by its white, flavorful, firm flesh which takes on a flaky texture after cooking. It is a versatile fish, readily adaptable to a wide variety of cooking methods and recipes and is wonderful for dieters when rich sauces are not used. Halibut steaks are available fresh in many markets and frozen in most markets. One pound will make two or three servings. Be sure to ask for true North Pacific halibut when you buy.

HALIBUT IN LEMON CREAM SAUCE

2 pounds halibut steaks, fresh or frozen
1 cup whipping cream
1 tablespoon lemon juice
1 tablespoon grated onion
1 teaspoon salt
Lemon slices
Chopped parsley

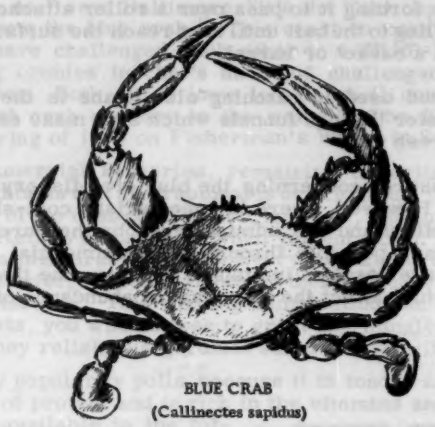
Thaw frozen steaks. Remove skin and bones and cut into 6 portions. Place fish in a single layer in a well-greased baking dish, 12 x 8 x 2 inches. Combine remaining ingredients except lemon slices and parsley. Pour sauce over fish. Bake in a moderate oven, 350° F., for 20 to 25 minutes or until fish flake easily when tested with a fork. Garnish with lemon slices and parsley. Makes 6 servings.

How can you tell when the halibut is cooked? Raw fish have a watery, translucent look. During the cooking process the watery juices become milky colored, giving the flesh an opaque, whitish tint. This color change is unmistakable. When the flesh has taken on this opaque whitish tint to the center of the thickest part, fish are completely cooked. At this point the flesh will easily separate into flakes, and if there are bones present, the flesh will come away from them readily.

Would you like to know more about how to cook fish? Let's Cook Fish (1 49.49/2:8) is a complete guide to fish cookery. This full-color booklet costs 60¢ and gives detailed information on market forms, how to buy, store, and thaw (if frozen), as well as how to cook fishery products. The booklet has many tested recipes and a handy timetable for easy reference on amounts to buy, cooking temperatures, and cooking methods.

How to Cook Halibut (1 49.39:9) is all about halibut, filled with tasty recipes, and costs 20¢. Both booklets are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. (Source: National Marketing Services Office, BCF, U.S. Dept. of the Interior, 100 East Ohio, Rm. 526, Chicago, Illinois 60611.)

FOOD FISH FACTS



BLUE CRAB
(Callinectes sapidus)

The blue crab, one of the most valuable crustaceans in the United States, is partially described by its scientific name. Calli - beautiful, plus nected - swimmer, and sapidus - savory. The blue crab is a savory shellfish that spends most of its time walking along the bottom of the bays and sounds where it lives. However, when necessary, it swims beautifully through the water with great speed and ease.

DESCRIPTION

Blue crabs, like other crabs, possess five pairs of legs with the first pair always equipped with pincers. Crabs have hard shells or exoskeletons. Periodically, in order to grow, they shed this external armor or shell. This process is called molting. Before the molt starts, a new, soft exoskeleton forms inside and the crab backs out of the old shell as it looses. The new shell is soft and elastic allowing the crab to grow. It is particularly vulnerable to attack during the soft-shell stage and seeks refuge in a secluded spot until the new shell hardens. Crabs also lose one or more legs during their lifetimes and are able to grow new ones through a regeneration process.

Blue crabs, when fully grown, average 5 to 7 inches across the back of the shell. The shell is brownish green or dark green and is drawn out on each side into a long spine. The underside of the body and the legs are white, while the tops of the claws in both male and female show varying amounts of blue. The tips of the claws in the femald blue crab are bright red.

HABITAT

Blue crabs are found along the Atlantic and Gulf coasts from Massachusetts to Texas. Essentially a shallow water crab, it lives in bays, sounds, and channels near the mouths of coastal rivers. Normally an inhabitant of salt water, the blue crab is also found in brackish water or fresh water.

BLUE CRAB FISHING

Blue crabs are caught with trawls, dredges, and baited lines such as the trotline. The trotline is a long length of rope with pieces of bait attached at intervals. It is laid on the bottom, ends anchored and marked with buoys. When the fisherman collects his catch he runs his boat along the line, forcing it to pass over a roller attached to the boat. As the boat

(Continued page 84.)

BLUE CRAB FISHING (Contd.)

runs his boat along the line, forcing it to pass over a roller attached to the boat. As the boat moves forward, the crabs cling to the bait until they reach the surface where they are caught with a dip net and placed in a basket or barrel.

Another efficient method used in catching blue crabs is the crab pot. This traplike device allows the crab to enter through funnels which also make escape difficult. The crab pot is usually baited with fresh fish.

Most conservation measures concerning the blue crab fishery are administered by the individual states involved. However, where the need exists, cost-sharing, cooperative Federal Aid Programs are in effect and are administered by the Bureau of Commercial Fisheries. These programs, made possible through the Commercial Fisheries Research and Development Act of 1964, have resulted in studies to determine the effects of temperature, salinity, and other factors which affect the survival and abundance of this important seafood.

Crab and trotline

USES OF BLUE CRABMEAT

Blue crabs are caught and marketed in both the hard-shelled and soft-shelled states. Soft-shelled crabs are considered a delicacy and bring higher prices. The entire body of a soft-shelled crab may be eaten after cooking. Hard-shelled crabs are either sold alive to the consumer; or they are steamed, the meat picked from the shell and packed into containers, refrigerated, and sold as fresh crabmeat. Crabmeat is marketed as lump meat - whole lumps from the large body muscles which operate the swimming legs; flake meat - small pieces of white meat from the body, flake and lump - a combination of the first two; and claw meat - a brownish tinted meat from the claws.

Pasteurization of blue crabmeat is another method of preparation for marketing. With pasteurization, the crabs are steamed, the meat picked from the shell and immediately packed into cans. The cans are hermetically sealed and immersed in a hog-water bath. This method does not alter the taste or texture of the meat, and it is fresh and table ready. Pasteurized crabmeat must be refrigerated until ready to use. Blue crabmeat is seldom frozen or canned. All crabmeat provides excellent high-quality protein, vitamins, and minerals. (Source: National Marketing Services Office, BCF, U.S. Dept. of the Interior, 100 East Ohio, Room 526, Chicago, Ill. 60611.)

CRAB-IN CREATED FOR CULINARY COMPETITION

"The West Coast is renowned for the tender, succulent meat from the Dungeness crab," says San Francisco. "No, no," says Baltimore, "it's the East coast that is renowned for the tender, succulent meat from the blue crab." This coast-to-coast argument has gone on for years, so the two cities have challenged each other to a CRAB-IN! Each city has rounded up famous, crab-cooking cronies in chef's hats and challenged them to a face-to-face, recipe-to-recipe encounter. Both cities have left no shell unturned in order to establish their claim to the "finest crab cookery in the world." The first National Crab-Cooking Olympics was held in spring of 1969 on Fisherman's Wharf in San Francisco.

The Bureau of Commercial Fisheries, remaining impartial in this great crustacean cooking competition, maintains that all crabmeat is delicious and can be used interchangeably in most recipes. In honor of the crab competition, however, the Bureau offers a sophisticated seafood treat to enjoy as a family luncheon or when you entertain. "Crab Stuffed Artichokes" will make any occasion a memorable affair. Everyone likes crab salad, and in this recipe the crabmeat is nested in tender, cooked artichokes, then topped with a gently-flavored sauce to enhance and blend the flavors. This winning combination can be prepared ahead of time, so, if you are having guests, you will be free to greet and mingle. They will say you have a "touch of genius" when they relish this gorumet salad served with such ease.

Crabmeat wins many popularity polls because it is tender and has a distinctive flavor. It is an excellent source of protein and is rich in the vitamins and minerals needed for good nutrition. Crabmeat is available in the following market forms: live; cooked in the shell; cooked meat, fresh or frozen; canned; or pasteurized.

Among crabs marketed in the United States are the blue crabs found along the Atlantic and Gulf coasts, Dungeness crabs found along the Pacific coast, king and snow or tanner crabs from Alaska, rock crabs found along New England and California coasts, stone crabs found mainly off Florida, and the queen crab found in waters of the North Atlantic.

CRAB STUFFED ARTICHOKES

- 1 pound crabmeat, fresh, frozen, or pasteurized
- 1 cup chopped celery
- ½ cup mayonnaise or salad dressing
- 2 hard-cooked eggs, chopped
- 2 tablespoons chopped green onion
- 2 tablespoons chopped pimiento
- 2 tablespoons chopped sweet pickle
- ½ teaspoon salt
- Dash pepper
- 6 cooked artichokes
- Vinaigrette Sauce

Thaw frozen crabmeat. Drain crabmeat. Remove any shell or cartilage. Combine all ingredients except artichokes and Vinaigrette Sauce. Gently open artichokes and fill each with ⅔ cup crab mixture. Chill. Serve with Vinaigrette Sauce. Makes 6 servings.

VANAIGRETTE SAUCE

- ½ cup salad oil
- 3 tablespoons vinegar
- 1 teaspoon salt
- ¼ teaspoon paprika
- 1 teaspoon minced parsley

Combine all ingredients. Makes approximately ⅔ cup sauce.

HOW TO COOK ARTICHOKES

- 6 artichokes
- 1½ quarts boiling water
- 1½ teaspoons salt
- 1 tablespoon oil
- 1 clove garlic, sliced

Wash artichokes. Trim stems. Cut 1 inch off tops of artichokes. With scissors, trim leaf tips. Stand upright in a 5-quart Dutch oven. Add boiling water and seasonings. Cover and cook gently for 20 to 35 minutes or until base can be pierced easily with a fork. Turn upside down to drain. Chill.

(Source: National Marketing Services Office, BCF, U.S. Dept. of the Interior, 100 E. Ohio, Room 526, Chicago, Ill. 60611.)

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UNITED STATES DEPARTMENT OF THE INTERIOR

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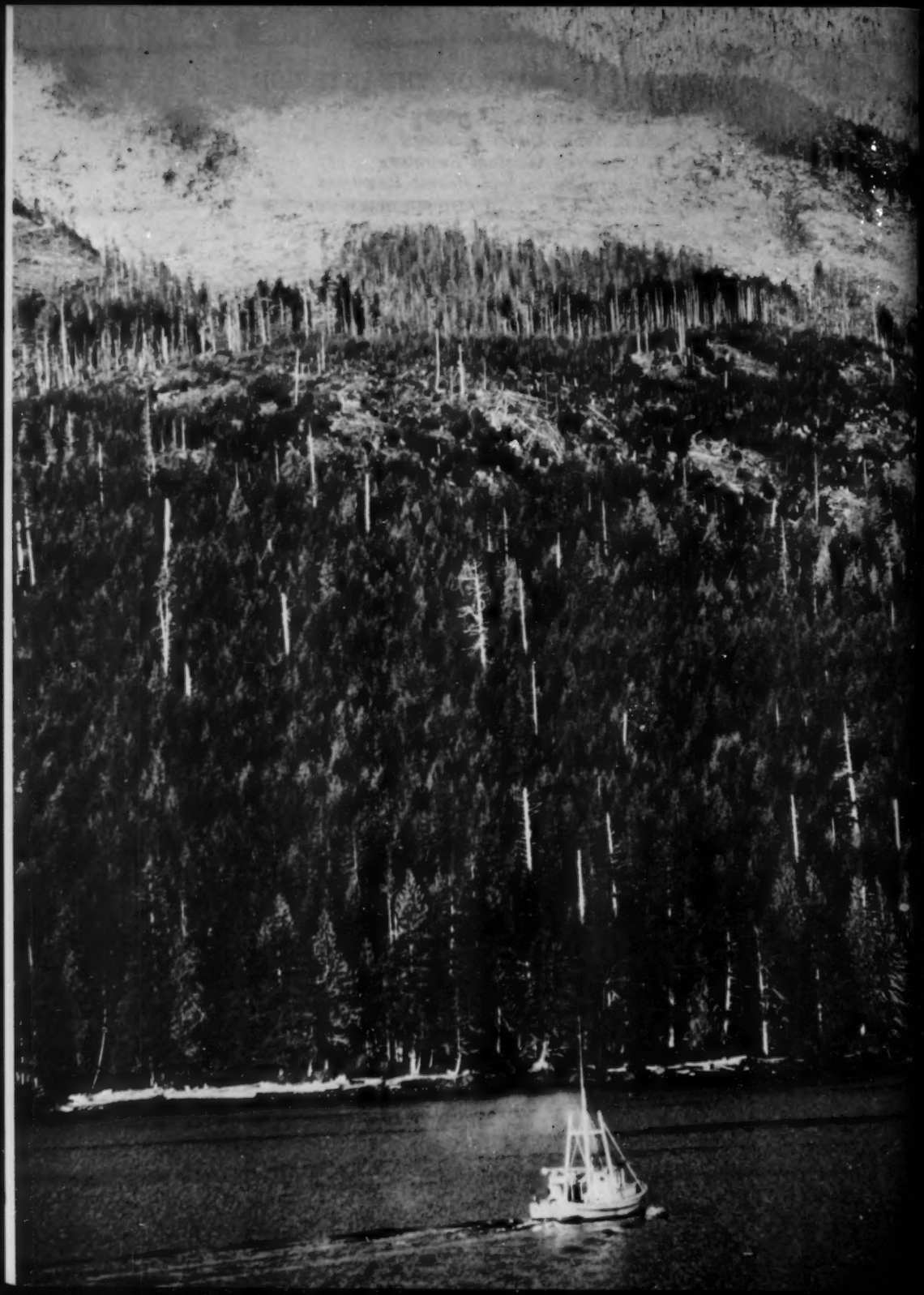
Charles H. Meacham, *Commissioner*, U.S. FISH AND WILDLIFE SERVICE

Philip M. Roedel, Director, BUREAU OF COMMERCIAL FISHERIES

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States -- now and in the future.

BACK COVER: Gill netter on Johnstone Strait, British Columbia. Vancouver Island in background. (Photo: F. Bruce Sanford)